SCIENCE

13 October 1961

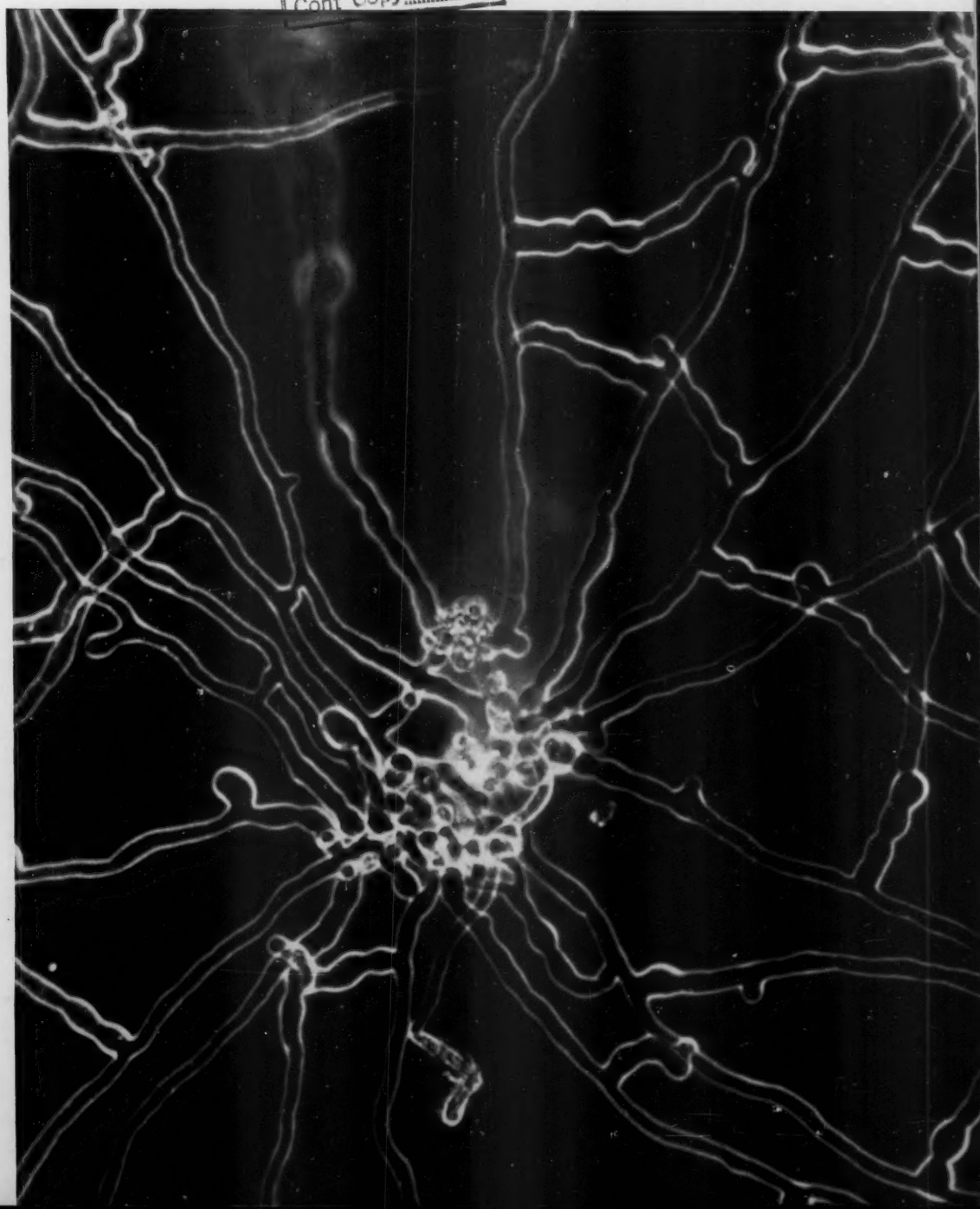
Vol. 134, No. 3485

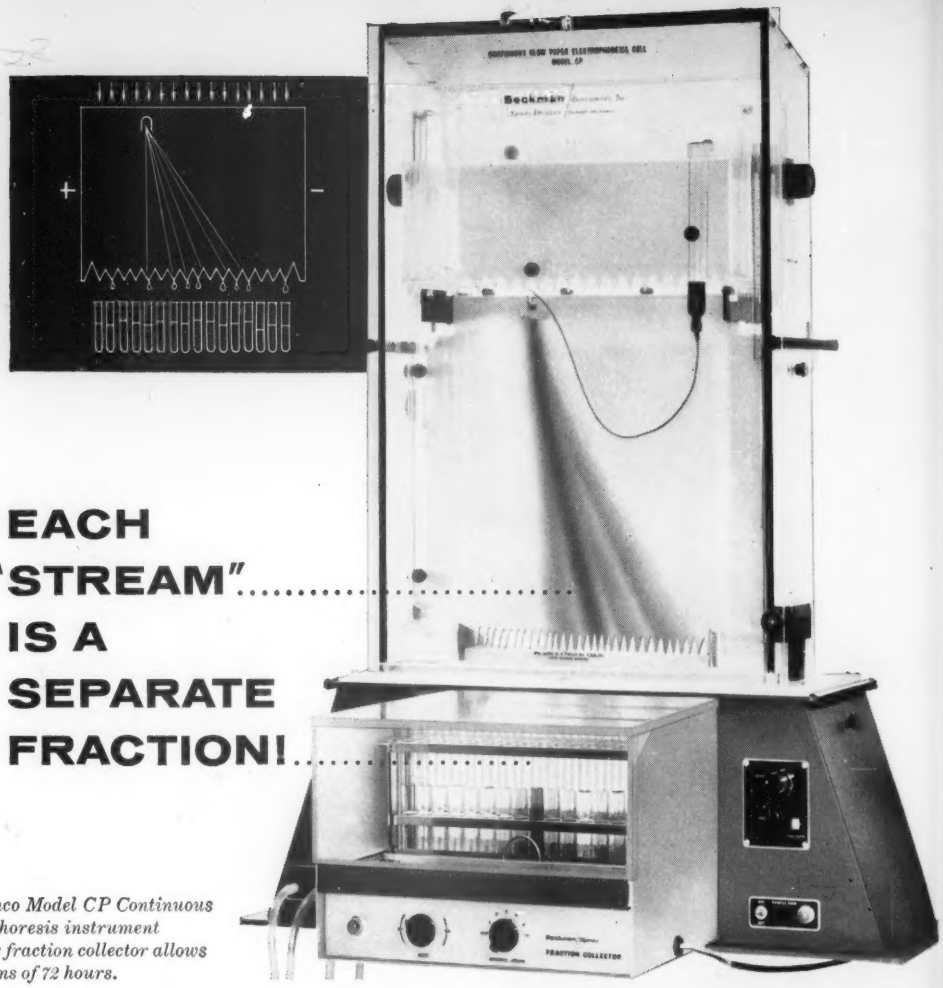
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

6 OCT 16 1961

Cont Copy 2

11-2-61





EACH "STREAM"..... IS A SEPARATE FRACTION!.....

Beckman/Spinco Model CP Continuous Flow Electrophoresis instrument with accessory fraction collector allows unattended runs of 72 hours.

As long as your biochemical or organic mixture is water-soluble and the fraction you want is ionized — chances are our Model CP Continuous Electrophoresis can separate it — and in quantity.

In the field for three years, the CP has solved a wide array of fractionating and purifying problems. In biochemistry the Spinco Model CP separates amino acids, peptides, hormones, sterols, bacteria, viruses, serum proteins and lipoproteins...is used in processing antibiotics and concentrating vaccines.

In organic chemistry the CP can isolate the end product in many types of reactions, in quantities up to a gram of pure material a day. Often the various side products can be separated as well.

If you face the problem of preparing pure fractions in volume, investigate the CP Continuous Electrophoresis now. Fill in the coupon and you will receive literature by return mail.

TO: Spinco Division, Beckman Instruments, Inc.
Stanford Industrial Park, Palo Alto 5, Calif.

☐ Please send me applications bulletin 6055 giving typical operating conditions and literature references.

☐ Please send descriptive literature and prices on the CP.

NAME_____

TITLE OR DEPARTMENT_____

FIRM OR INSTITUTION_____

ADDRESS_____

CITY_____ STATE_____

Beckman® / **Spinco Division**
Beckman Instruments, Inc.

5-55A

PROBABLY THE WATER IS ALL RIGHT!

A cool drink from the common cup. A small chance. Usually no one suffers for it. Usually. It's human nature to take chances. Except at Nutritional Biochemicals. There, human nature gives way to perfectionism. Because lives depend on the absolute purity of N.B.Co.'s biochemicals. So does successful research. In ordering one of N.B.Co.'s 2600 biochemicals, you express confidence. Confidence in a company whose only business is preparing pure biochemicals. A company whose world-wide volume brings you pure biochemicals at low prices. Send for our Free catalogue today. Or call us at MOntrose 2-0214, Cleveland, Ohio.

NUTRITIONAL BIOCHEMICALS CORPORATION
21010 Miles Avenue • Cleveland 28, Ohio
24-Hour Delivery in the U.S.A. • Slightly Longer Anywhere Else

Send for our free October, 1961 Catalog containing more than 2600 items. Fill out coupon and mail today for your copy. SC

Name _____

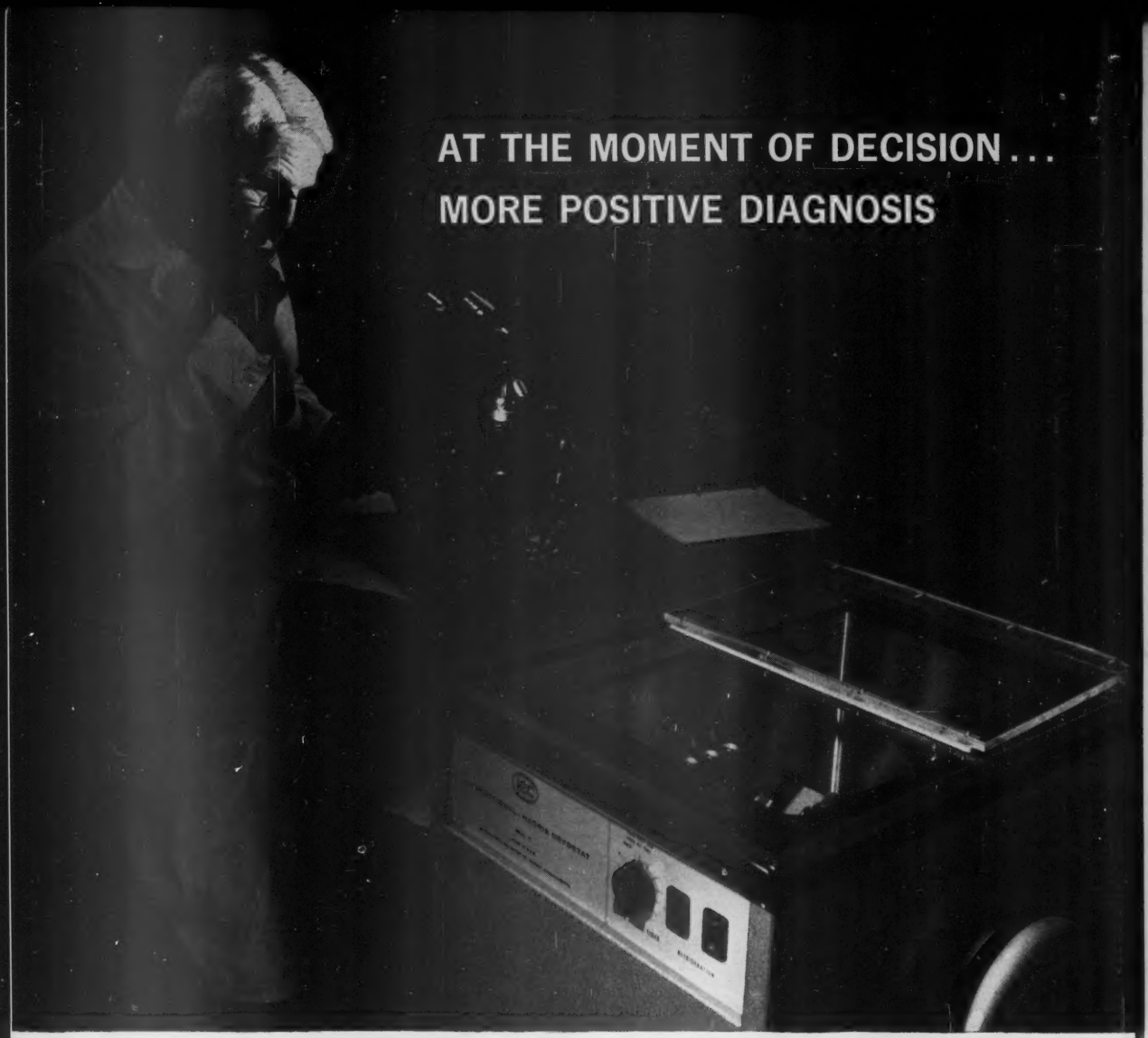
Organization _____

Address _____

City _____

State _____ Zone _____

SCIENCE is published weekly by the AAAS, 1515 Massachusetts Ave., NW, Washington 5, D.C. Second-class postage paid at Washington, D.C., and additional mailing office. Annual subscriptions: $8.50; foreign postage, $1.50; Canadian postage, 75¢.



To provide more positive diagnosis . . . to speed slide preparation . . . to perfect it technically and thereby produce exceptional cytological detail in thin undistorted sections . . . these are the aims and accomplishments of International's new model CT Microtome Cryostat.

Everything necessary for precise, frozen sectioning has been conveniently packaged in one superbly engineered compact instrument. From fresh tissue to finished slide in minutes. There is a new, integral Freon fast freezing arrangement. Controlled temperatures from −10°C to −20°C are held even with the top open. Laboratories significantly speed their service. Pathologists get the best possible sections to help them achieve diagnostic certainty even under pressure of time. Write for our latest brochure.

INTERNATIONAL (IEC) EQUIPMENT CO.

1284 SOLDIERS FIELD ROAD · BOSTON, MASS.

13 October 1961, Volume 134, Number 3485

SCIENCE

Editorial

What Goes Down Must Come Up 1039

Articles

Demineralization of Saline Waters: *W. S. Gillam* and *J. W. McCutchan* 1041
Current desalination processes and research give hope for solution of our impending water crisis.

Olfactory Stimuli in Mammalian Reproduction: *A. S. Parkes* and *H. M. Bruce* 1049
Odor excites neurohumoral responses affecting oestrus, pseudopregnancy, and pregnancy in the mouse.

Science and the News

The Joint Committee and the Atomic Energy Commission: A Case of Shared Management; Civil Defense: For Strategic Reasons, the Administration Has Limited Goals 1055

Book Reviews

Rock 'n' Roll: *W. Petersen* 1061
Is there an adolescent subculture in our society, with its own elite group, independent values, and aspirations?

A. R. Luria's *The Role of Speech in the Regulation of Normal and Abnormal Behavior*, reviewed by *J. J. Jenkins*; other reviews 1063

Reports

Colonial Growth of *Neurospora: N. de Terra* and *E. L. Tatum* 1066
Sorbose and enzymes alter the composition of the cell wall and induce morphological changes.

Measurement of the Relations between Chromosomes and Behavior: *L. Erlenmeyer-Kimling* and *J. Hirsch* 1068

Reversal of Phenylalkylamine Tachyphylaxis by Norepinephrine: *F. F. Cowan* et al. ... 1069

Interstitial Waters of Recent Marine Muds Off Cape Cod: *R. Siever* et al. 1071

Spontaneous Ejaculation in Rat: *J. Orbach* 1072

Immunization to *Schistosoma mansoni* in Mice Inoculated with Radiated Cercariae: *J. B. Villella, H. J. Gomberg, S. E. Gould* 1073

Senescence Inhibition and Respiration: *R. R. Dedolph, S. H. Wittwer, V. Tuli* 1075

Explanation of Cocaine Desensitization of Blood Pressure Responses to Ephedrine: *C. Cannon* et al. 1075

Absence of the Diego Antigen, a Genetic Characteristic of Early Immigrants to South America: *M. Layrisse* and *J. Wilbert* 1077

Effect of Deuteration of N–CH_3 Group on Potency and Enzymatic N-Demethylation of Morphine: *C. Elison* et al. 1078

Departments

New Products; Forthcoming Events 1080

Cover

Dark-field photographs of wild type *Neurospora crassa* hyphae; 18-hour culture, 30°, on minimal agar medium containing 0.2 percent dextrose, 0.2 percent glycerol, and 1.5 percent sorbose (× 760). See page 1066.

WILEY BOOKS

The AMERICAN COLLEGE

A Psychological and Social Interpretation of Higher Learning

Edited by NEVITT SANFORD, *Stanford University*. Bringing together the contributions of an outstanding group of social scientists, this book offers a penetrating analysis of college education in America. It represents the first large-scale attempt to apply modern social and psychological theory to the study of college students and their behavior and of the college itself as a social institution. *1962. In press.*

PROBABILITY AND EXPERIMENTAL ERRORS in SCIENCE—An Elementary Survey

By LYMAN G. PARRATT, *Cornell University*. Clarifies the relationship of statistics and probability theory to problems in modern physical science, and teaches the mechanics involved in applying the proper formulas to scientific situations. *1961. 255 pages. $7.25.**

THOUGHT and LANGUAGE

By LEV SEMENOVICH VYGOTSKY, *Translated and edited by* EUGENIA HANFMANN, *Brandeis, University, and* GERTRUDE VAKAR. An M.I.T. Press Book. *1961. In press.*

PSYCHOLOGY of JUDGMENT and CHOICE

By FRANK RESTLE, *Michigan State University. 1961. 235 pages. $6.95.*

BIRD STUDY

By ANDREW J. BERGER, *University of Michigan Medical School. 1961. 389 pages. $9.00.**

GENERAL BIOLOGY

Fourth Edition

By EARL L. CORE, *and* PERRY D. STRAUSBAUGH, *both of West Virginia University; and* BERNAL R. WEIMER, *Bethany College. 1961. Approx. 528 pages. $7.95.*

A NEW MANUAL for the BIOLOGY LABORATORY

Third Edition

By BERNAL R. WEIMER, EARL L. CORE, *and* ROY B. CLARKSON, *West Virginia University. 1961. Approx. 256 pages. Prob. $4.25.*

DISPERSION RELATIONS and ELEMENTARY PARTICLES

Edited by CECILE DE WITT, *Director of the Les Houches Summer School for Theoretical Physics; and* R. OMNES. *1961. 671 pages. $20.00.*

CYBERNETICS, or Control and Communication in the Animal and the Machine

Second Edition

By NORBERT WIENER, *M.I.T.* A revised edition of a work that is world-renowned for its implications for modern life and technology. Among other changes, it contains two new chapters and a new introduction by Professor Wiener. *1961. 212 pages. $6.50.*

QUANTUM MECHANICS

By EUGEN MERZBACHER, *University of North Carolina.* This useful introduction to non-relativistic quantum mechanics stresses the physical ideas and mathematical techniques which are most commonly encountered in practice and which will best prepare the reader for further and more specialized study. *1961. 544 pages. $12.00.**

PHYSICAL CHEMISTRY of MACROMOLECULES

By CHARLES TANFORD, *Duke University*. Shows how fundamental theory in each major area of physical chemistry can be modified or extended so as to become applicable to molecules of very high molecular weight. *1961. 710 pages. $18.00.**

PARTITION of CELL PARTICLES and MACROMOLECULES

Distribution and Fractionation of Cells, Viruses, Microsomes, Proteins, Nucleic Acids, and Antigen-Antibody Complexes in Aqueous Polymer Two-Phase Systems

By PER-ÅKE ALBERTSSON, *University of Uppsala, Sweden. 1961. 232 pages. $7.00.*

An INTRODUCTION to INFRARED SPECTROSCOPY

By WERNER BRÜGEL, *Badische Anilin und Soda-Fabrik, Ludwigshafen, Germany. 1961. 406 pages. $9.00.*

The CHROMOSOMES, Third Edition

By M.J.D. WHITE. One of the Methuen Monographs on Biological Subjects. *1961. 188 pages. $3.25*

VERTEBRATE REPRODUCTIVE CYCLES

Second Edition

By W. S. BULLOUGH. One of the Methuen Monographs on Biological Subjects. *1961. 123 pages. $2.95.*

MEDICINAL CHEMISTRY, Volume V

Edited by WALTER H. HARTUNG, *Medical College of Virginia; and* ERNEST E. CAMPAIGNE, *Indiana University. 1961. Approx. 448 pages. $18.00.*

**Textbook edition also available for college adoption.*

Send for examination copies.

JOHN WILEY & SONS, Inc. **440 Park Avenue South, New York 16, N.Y.**

Now–Determine Na and K Simultaneously

...in less than 20 seconds

NEW BAIRD-ATOMIC FLAME PHOTOMETER PROVIDES TWO DETERMINATIONS FROM JUST ONE DILUTION WITH ±0.5% REPRODUCIBILITY.

A single 0.05cc sample (diluted 1:200) – and a flick of a switch...that's all it takes to accurately determine Na and K concentrations with the Baird-Atomic Flame Photometer, Model KY. Tedious calculations, between-run cleanings and recalibrations are gone forever.

Its exclusive B/A Multilayer Filters provide a rejection factor of more than 99.9% at unwanted wavelengths making it more efficient than spectrophotometer-type instruments. Compact and portable, the B/A Model KY operates equally well on manufactured, natural or bottle gas. Because of its sealed air system and thorough shielding, readings are not affected by tobacco smoke, solvent fumes or other airborne contaminants.

Write today for more complete information . . . Engineers and scientists — investigate challenging opportunities with Baird-Atomic.

Only the Baird-Atomic Flame Photometer offers you the combined advantages of:

- **Instantaneous meq/liter readout**
- **Double beam instrument accuracy**
- **Simultaneous single-sample determinations**

B/A Flame Photometer Condensed Specifications. Metals Analyzed and Guaranteed Sensitivity (1% of full scale):

Metal	meq/l	mg%	ppm
Na	0.001	0.002	0.02
K	0.0025	0.001	0.01
Li	0.028	0.02	0.02

Reproducibility: ±0.5% av. Size: 15" x 17" x 16" Wgt.: 35 lbs.

BAIRD-ATOMIC, INC.

33 university road · cambridge 38, mass.

ADVANCED OPTICS AND ELECTRONICS . . . SERVING SCIENCE

GET YOUR ADVANCE COPY

of the General Program of the AAAS Denver Meeting

by first class mail – early in December

The *General Program* of the 128th Meeting of the AAAS in Denver, 26–31 December 1961, will be available to you, at cost, within the first week in December—whether you can attend the Meeting or not.

Program Content

1. The two-session AAAS General Sessions, "Moving Frontiers of Science," Part I—Speakers: Howard A. Meyerhoff and Arthur R. von Hippel; Harrison Brown, presiding. Part II—Speakers: Halton C. Arp and E. W. Fager; Harrison Brown, presiding.
2. The 29th John Wesley Powell Memorial Lecture. Speaker: Glenn T. Seaborg; Paul M. Gross, presiding.
3. On "AAAS Day," the four broad, interdisciplinary symposia—Physics of the Upper Atmosphere; Geochemical Evolution—The First Five Billion Years; Existing Levels of Radioactivity in Man and His Environment; and Water and Climate—arranged by AAAS Sections jointly.
4. The Special Sessions: AAAS Presidential Address and Reception; Joint Address of Sigma Xi and Phi Beta Kappa by Harrison Brown; the Tau Beta Phi Address by John A. Logan; National Geographic Society Illustrated Lecture; and the second George Sarton Memorial Lecture.
5. The programs of all 18 AAAS Sections (specialized symposia and contributed papers).
6. The programs of the national meetings of the American Astronomical Society, American Society of Criminology, American Nature Study Society, American Society of Naturalists, American Society of Zoologists, Beta Beta Beta Biological Society, Biometric Society (WNAR), National Association of Biology Teachers, Scientific Research Society of America, Society for General Systems Research, Society of Protozoologists, Society of Systematic Zoology, and the Society of the Sigma Xi.
7. The multi-sessioned special programs of the American Association of Clinical Chemists, American Astronautical Society (Hugh L. Dryden as dinner speaker), American Meteorological Society, American Physiological Society, American Psychiatric Association, Association of American Geographers, Ecological Society of America, National Science Teachers Association, National Speleological Society—and still others, a total of some 70 to 80 participating organizations.
8. The sessions of the Academy Conference, the Conference on Scientific Communication, and the Conference on Scientific Manpower.
9. The sessions of the AAAS Cooperative Committee on the Teaching of Science and Mathematics, of the AAAS Committee on Science in the Promotion of Human Welfare.
10. Titles of the latest foreign and domestic scientific films to be shown in the AAAS Science Theatre.
11. Exhibitors in the 1961 Annual Exposition of Science and Industry and descriptions of their exhibits.

Advance Registration

Advance registration has these decided advantages: (1) You avoid delay at the Registration Center upon arrival; (2) You receive the *General Program* in ample time to decide, unhurriedly, which events and sessions you particularly wish to attend; (3) Your name is posted in the Visible Directory as the Meeting opens.

The following coupon may be used both by advance registrants and by those who wish only the advance copy of the *General Program*.

———————THIS IS YOUR COUPON FOR AN ADVANCE COPY OF THE GENERAL PROGRAM———————

1a. ☐ Enclosed is $3.50 for my advance Registration Fee which brings me the *General Program*, Convention Badge, and all privileges of the Meeting (50¢ is for first-class postage and handling).

1b. ☐ Enclosed is $2.50 for only the *General Program*. (It is understood that, if I should attend the Meeting later, the Badge—necessary for the privileges of the Meeting—will be secured for $1.00 more.)
(check 1a or 1b)

2. FULL NAME (Dr., Miss, etc.) .....
(Please print or typewrite) (Last) (First) (Initial)

3. OFFICE OR HOME ADDRESS .....
(For receipt of *General Program*)

CITY ..... ZONE ..... STATE .....

4. FIELD OF INTEREST .....

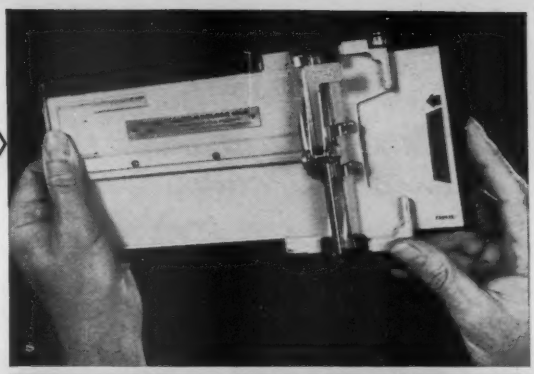
5. ACADEMIC, PROFESSIONAL, OR BUSINESS CONNECTION .....

6. CONVENTION ADDRESS .....
(May be added later, after arrival)

Please mail this coupon and your check or money order for the total amount to the
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
1515 Massachusetts Avenue, NW, Washington 5, D.C.

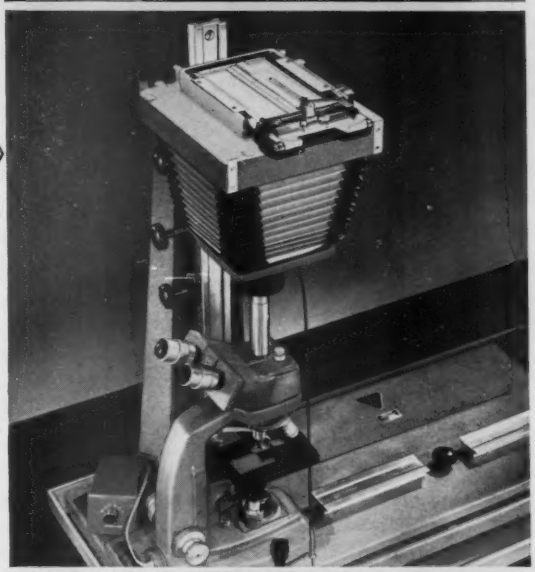
ORDERS RECEIVED AFTER 15 DECEMBER 1961 CANNOT BE PROCESSED

Put this Polaroid® Land 4x5 Film Holder...



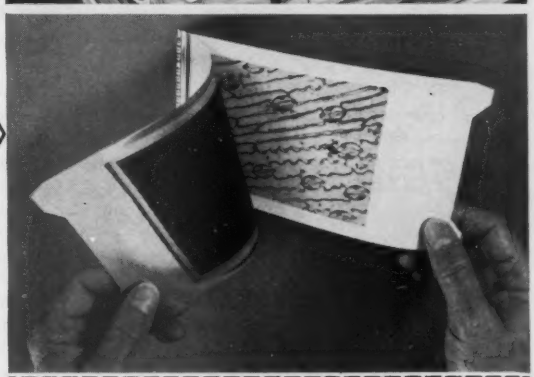
Get photomicrographs faster than ever before, the famous Polaroid "ten second" picture way. The high resolution and contrast of Polaroid Land films assure the critical image quality you want.

...on this Bausch & Lomb Model L Camera



Here's new speed and versatility in photomicrography. Now the Model L Camera is available with the new B&L DynaZoom* Laboratory Microscope—zoom up, zoom down in the range you select... from 17.5× to 1940×. Photograph *any* specimen—transparent or opaque—at *any* power from the highest to the lowest—the ultra-fast way with Polaroid Land Film!

...get sharp photomicrographs in just 10 seconds!



Save the time of developing ordinary film. Free the camera for other work. Be sure you get the shots you need, in both print and negative form. Picture the big savings of time and money in your own lab.

©by Polaroid Corp.
*Trademark, Bausch & Lomb

BAUSCH & LOMB
SINCE 1853

Made in America, to the world's highest standards.

BAUSCH & LOMB INCORPORATED
85622 Bausch Street, Rochester 2, N. Y.

☐ I'd like a demonstration of B&L Model L Camera and Polaroid Land Film Holder.

☐ Please send Catalogs E-21, E-22.

NAME, TITLE.....

PROFESSIONAL ADDRESS.....

.....

We interrupt our series to bring you a special announcement

IT HAPPENED THIS MONTH...

a glance at tomorrow in relation to today

IN OCTOBER – (1961) – Schwarz BioResearch dedicates this new building at Orangeburg, New York. It rededicates itself to providing the finest biochemicals, through integrated research, production, quality control, and distribution.

The new 30,000 sq. ft. building – housing an enlarged scientific staff and modern equipment – is designed to be a most efficient and most economical source of biochemicals. Thus, we are better prepared to meet your requirements, from the most exacting microscale radiochemicals for fundamental research to tonnage lots of compounds for industrial use.

IN EVERY MONTH: *NEW BIOCHEMICALS—more nucleic acid compounds, intermediates in carbohydrate metabolism, peptides, and sulfhydryl compounds.—NEW RADIOCHEMICALS—more C^{14}-labeled and tritiated compounds—many at specific activity levels higher than heretofore obtainable—providing improved tools for precise studies of metabolic processes, and physiological and biochemical reactions.—NEW PHARMACEUTICALS—we anticipate an increasing need to prepare special types of biochemical compounds for use in clinical investigation. Such compounds may also be radiolabeled.—NEW STANDARDS OF PURITY—We accept the criteria of the National Research Council, recommended as a floor—not a ceiling—for our quality standards. More effective methods of production will allow even more exacting standards of purity. Each product you order will be accompanied by full and exact analytical data.—EXPANDED RESEARCH AND DEVELOPMENT—we will continue to provide an ever wider range of compounds for research in the structure and function of DNA and RNA. Our new facilities will permit us to do more contract research for government and industry. And we are expanding our development and manufacturing program for THIOGEL®, the new thiolated gelatin with special applications in the fields of enzyme stabilization, photography, drugs, and cosmetics.—SPECIAL SERVICES—facilities for custom preparation of labeled compounds will be substantially increased, especially in respect to tritiation and P^{32} incorporation.*

You are cordially invited to visit us at our new location. You are also invited to write for a copy of our new catalog.

SCHWARZ BIORESEARCH, INC. • Dept. 10B • Mountain View Ave., Orangeburg, N. Y.
BIOCHEMICALS • RADIOCHEMICALS • PHARMACEUTICALS *for research, for medicine, for industry*

13 October 1961, Volume 134, Number 3485

SCIENCE

AMERICAN ASSOCIATION
FOR THE
ADVANCEMENT OF SCIENCE

Board of Directors

CHAUNCEY D. LEAKE, *Retiring President, Chairman*
THOMAS PARK, *President*
PAUL M. GROSS, *President Elect*

HARRISON BROWN — DON K. PRICE
HENRY EYRING — ALFRED S. ROMER
H. BENTLEY GLASS — WILLIAM W. RUBEY
MARGARET MEAD — ALAN T. WATERMAN

PAUL A. SCHERER, *Treasurer*
DAEL WOLFLE, *Executive Officer*

Editorial Board

KONRAD B. KRAUSKOPF — H. BURR STEINBACH
EDWIN M. LERNER — WILLIAM L. STRAUS, JR.
PHILIP M. MORSE — EDWARD L. TATUM

Editorial Staff

DAEL WOLFLE, *Publisher* — HANS NUSSBAUM, *Business Manager*

GRAHAM DUSHANE, *Editor*

JOSEPH TURNER, *Associate Editor* — ROBERT V. ORMES, *Managing Editor*

ELLEN E. MURPHY, *Assistant Editor*

NANCY TEIMOURIAN, *Assistant to the Editor*

News: HOWARD MARGOLIS, DANIEL S. GREENBERG, PATRICIA D. PADDOCK

Book Reviews: SARAH S. DEES

Editorial Assistants: SUE E. BERKE, NANCY S. HAMILTON, OLIVER W. HEATWOLE, EDGAR C. RICH, JOHN E. RINGLE, CONRAD YUNG-KWAI

Staff Assistants: GENEVIEVE M. KIRBY, JEAN P. D. PIEKNIK

Advertising Staff

EARL J. SCHERAGO, *Director*

BERNICE SCHWARTZ, *Production Manager*

Sales: RICHARD L. CHARLES (New York, N.Y., PE 6-1858); C. RICHARD CALLIS (Old Bridge, N.J., CL 4-3680); HERBERT BURKLUND (Chicago, Ill., DE 7-4973); DILLENBECK-GALAVAN (Los Angeles, Calif., DU 5-3991)

SCIENCE, now combined with THE SCIENTIFIC MONTHLY, is published each Friday by the American Association for the Advancement of Science at National Publishing Company, Washington, D.C. SCIENCE is indexed in the *Reader's Guide to Periodical Literature*.

Editorial correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D.C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts. Opinions expressed by authors are their own and do not necessarily reflect the opinions of the AAAS or the institutions with which the authors are affiliated. For detailed suggestions on the preparation of manuscripts, see *Science* **125**, 16 (4 Jan. 1957).

Advertising correspondence should be addressed to SCIENCE, Room 1740, 11 West 42 St., New York 36, N.Y.

Change of address notification should be sent to 1515 Massachusetts Ave., NW, Washington 5, D.C., 4 weeks in advance. Furnish an address label from a recent issue. Give both old and new addresses, including zone numbers.

Annual subscriptions: $8.50; foreign postage, $1.50; Canadian postage, 75¢. Single copies, 35¢. School year subscriptions: 9 months, $7.00; 10 months, $7.50. Cable address: Advancesci, Washington.

Copyright © 1961 by the American Association for the Advancement of Science.

What Goes Down Must Come Up

When the time comes to make science fiction awards for 1961, the judges will want to look beyond purely literary efforts. A great talent is beginning to make itself felt from another field of endeavor. For soaring fantasy unencumbered by regard for fact, it is going to be hard to beat India's Defense Minister V. K. Krishna Menon's implication, offered in comments last month to the Foreign Correspondents Association in New Delhi, that American underground testing of nuclear weapons is potentially more dangerous than Soviet atmospheric testing.

Krishna Menon implied that atmospheric tests would produce less fallout than underground tests. His explanation, to quote the Associated Press dispatch upon which this report is based, was that atmospheric tests "do not suck up earth and contaminate it," while underground tests are potentially more dangerous because "they involve the ground." Under questioning, Menon declined to concede that the Americans, in order to reduce hazards in testing, are going to more trouble and expense than the Russians. Each side, he said, conducts the kind of tests it finds most useful, and each side uses the arguments that suit its purposes.

But masterly as is the Indian Defense Minister's analysis, we do not propose to sit idly by and watch science fiction honors leave this country unchallenged. And so in a spirit of friendly international competition, we have also let our imagination rise unweighted by mere fact and have come up with the following tale.

Project Mohole is familiar to many people as the effort in which American scientists plan to drill a hole, at great trouble and expense, through the earth's outer layer down to the interior. Preliminary drillings beneath the ocean demonstrating the feasibility of the effort have been well publicized. Unfortunately, what is not so well known is that the uses of the project bear directly on the American nuclear weapons program.

The contention that underground testing is potentially more dangerous than atmospheric testing is, of course, quite correct. The American claim, as sometimes reported in the press, that underground testing is safe because the effects are contained within a subterranean chamber is also correct as far as it relates to the earth's outer crust, but there remains the danger of the *inner* crust.

The earth being hollow, the real danger is not that radioactive particles will be released into the atmosphere, but that the explosion will break through the inner crust, releasing the poison into the earth's interior. Then, as the pressure in the interior rises above atmospheric pressure, the poisoned gases will be sucked up through porous sections of the earth—generally farm areas, because of repeated plowing—contaminating the earth as they pass. What goes down must come up.

It is this hazard that Project Mohole is expressly designed to eliminate. The hole will provide a safety valve through which the radioactive particles can escape. Moreover, the particles will not simply be released into the air, as in atmospheric testing. But, because of the design of the hole, they will be expelled with such velocity as to shoot directly from inner to outer space, and so produce a geyser that should be a wonder and joy to behold for East, West, and neutral alike.—J.T.

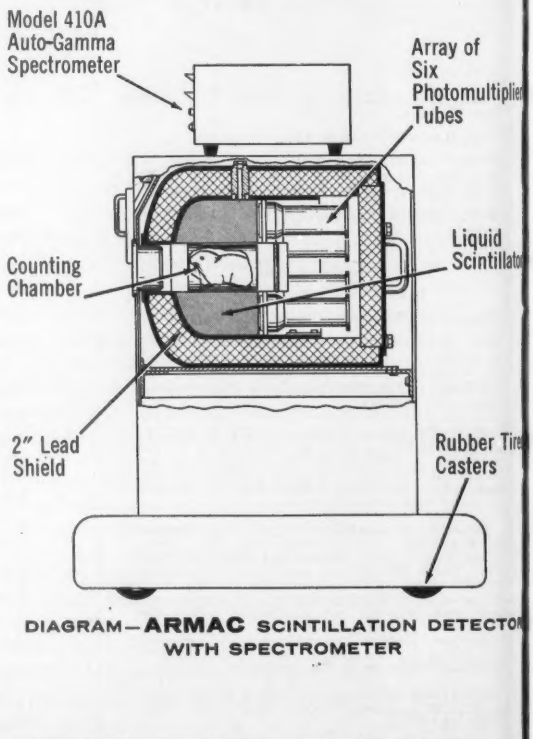
NEW

The PACKARD ARMAC® Scintillation Detector...

A compact, wholly self-contained liquid scintillation detector that can be used as a whole body counter for small animals, as a radioactivity counter for bulk samples of foods, soils and other materials, and as an arm-only counter on humans.

This versatile and economical new instrument enables the research worker to count even natural levels of radioactivity conveniently. Because of the great sensitivity and excellent counting geometry of the ARMAC Detector, high counting rates can be obtained with the administration of very small amounts of radio-nuclides . . . only 1/100 to 1/1000 of maximum permissible levels.

A complete system consists of the ARMAC Detector and a Model 410A Auto-Gamma Spectrometer, both mounted on a mobile housing. Provision is made for addition of automatic data read-out or ratemeter presentation. Complete information can be obtained from your Packard Sales Engineer or by writing direct to the company.



DIAGRAM—**ARMAC** SCINTILLATION DETECTOR WITH SPECTROMETER

Announcing: 5th Annual Symposium on Advances in Tracer Methodology, Washington, D. C., Oct. 20. Write us for program and advance registration.

Packard

BRANCH OFFICES

CHICAGO • ALBUQUERQUE • ATLANTA • BOSTON • DALLAS
LOS ANGELES • NEW YORK • PHILADELPHIA • PITTSBURGH
SAN FRANCISCO • WASHINGTON, D.C. • ZURICH • HANOVER • PARIS

PACKARD INSTRUMENT COMPANY, INC.

LA GRANGE 54, ILLINOIS, Telephone HUnter 5-6330

13 October 1961, Volume 134, Number 3485 SCIENCE

CURRENT PROBLEMS IN RESEARCH

Demineralization of Saline Waters

Current desalination processes and research give hope for solution of our impending water crisis.

W. S. Gillam and J. W. McCutchan

It has been stated that there are three basic water economies in the United States: The East uses water, the central states are processors of water, and the western states are water redistributors. As sources of water for use, processing, or redistribution become more scarce, the need for converted sea water comes into sharper focus.

Congress recognized the need for new sources of fresh water in 1952, passed the Saline Water Act (Public Law 448), amended it in 1955, and in September 1958 passed Public Law 85-883 calling for the construction of at least five saline-water-conversion demonstration plants. The primary objective of the Saline Water Conversion Program is to develop low-cost processes for converting saline waters to potable water. A number of surveys have indicated that within one or two decades the United States may be in real difficulty as a result of water shortages, since the population growth will triple the demand for fresh water by 1980, and since the United States has built up a large interdependent water complex that is subject to serious disruption in the event of a water shortage (Fig. 1).

Government officials (*1*) have stated that by 1980 an adequate supply of potable water may be our number-one problem. New estimates of water use and supply suggest that the critical period will begin about 10 years earlier, by 1970 (*2*). The quantity of natural fresh water which this nation can expect to have regularly available in 1980 will be about 515 billion gallons a day. In 1960 the daily use was calculated at 323 billion gallons, whereas the total dependable supply was estimated at 315 billion gallons (*2*).

Is this future demand going to be met? Justus H. Fugate, at the December 1960 National Conference on Water Pollution, said, "In spite of the effort at the Federal level, and in spite of substantial effort at the municipal and state levels, there are not now under construction or even planned for construction, by all the public and private agencies combined, sufficient water projects to provide the amount of water of acceptable quality that we will require in 1975. The naked fact is the United States faces a water crisis."

The extent of interest in obtaining additional supplies of fresh water within the United States is illustrated in Fig. 2. This figure shows the location of cities which asked to be considered as sites for the demonstration plants to be built under supervision of the Office of Saline Water, U.S. Department of the Interior. The stars indicate the sites selected for the five demonstration plants: Freeport, Texas; San Diego, California; Webster, South Dakota; Roswell, New Mexico; and Wrightsville Beach, North Carolina. The fact that this is a world-wide problem was emphasized by a survey made by UNESCO (*3*), in 1958, of institutions engaged in research on sea-water conversion. France, Hungary, India, Iraq, Israel, Italy, Japan, the Netherlands, Spain, Switzerland, the Union of South Africa, the United Kingdom and Northern Ireland, the United States, Yugoslavia, and Australia have all reported research activities at various institutions. The U.S.S.R. is also known to be actively engaged in research on the problem of demineralization of saline water.

Research Problems in Distillation

No general review of sea-water conversion would be complete without some discussion of the distillation processes. No matter how new the design of the process equipment, the fact that it is based on distillation places it in the category of development rather than that of basic research. Nevertheless, current research problems do exist. These are not new problems, but a new research point of view may be necessary for their solution.

The problems fall into four general categories: (i) studies of the composition of scale and its elimination or control; (ii) investigations of materials of construction of sea-water evaporators, from the point of view of corrosion resistance and economic life; (iii) development of means of raising the level of operating temperatures, for the hope of improving fuel economy lies in achieving an increase in temperature

Dr. Gillam is chief of the division of research, Office of Saline Water, U.S. Department of the Interior, Washington, D.C. Mr. McCutchan is associate professor of engineering, University of California, Los Angeles, now on sabbatical leave at the Office of Saline Water, U.S. Department of the Interior.

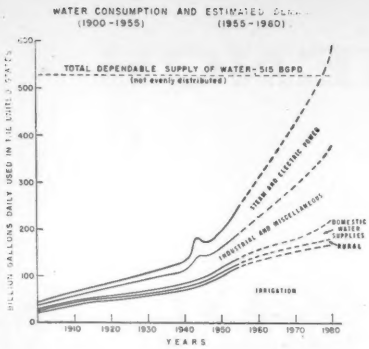


Fig. 1. Water consumption and estimated demand to 1980.

level; and (iv) a design study based on optimizing mass transfer.

The classic work of W. F. Langelier *et al.* (*4*) on scale control in sea-water distillation equipment established a means for predicting the type of scale to be expected under specific operating conditions. On the basis of this work it was found that equipment could be operated in the $CaCO_3$ or $Mg(OH)_2$ range, and that scale could then be periodically removed by acid treatment. Another answer was to use vacuum distillation, keeping the temperature below 160° to 180°F, then with a sufficiently high rate of blowdown, to operate relatively free of scale.

However, the goal of converting sea water by means that are economically competitive motivates us to look for ways of eliminating or controlling the scale problem instead of being limited by it. The work of Banchero and Gordon (*5*) at the University of Michigan, sponsored by the Office of Saline Water, represents a new effort to make a fundamental study of scale deposition on heated surfaces. As the temperature level is raised in sea-water equipment, calcium sulfate and its hydrate forms, hemihydrate and gypsum, become most important scale constituents. Gordon is currently studying calcium sulfate deposition. Kelley *et al.* (*6*) have also made an important contribution to the solution of this problem in their publication "Thermodynamic properties of gypsum and its dehydration products."

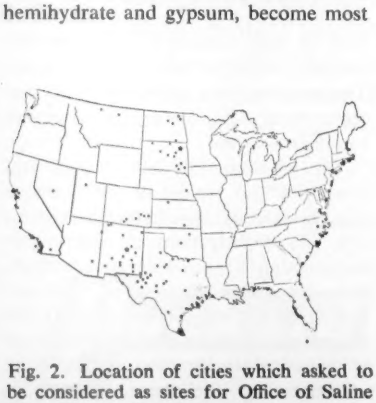


Fig. 2. Location of cities which asked to be considered as sites for Office of Saline Water Conversion plants.

A fundamental study on critical conditions for scaling of solutions on heating or cooling surfaces has just been reported by J. L. Chandler (*7*). According to his study, crystals are deposited on the surface at a rate approximately proportional to a power of the degree of supersaturation at the surface.

A survey on construction materials for handling saline waters, with special emphasis on the problems involved, was conducted by Battelle Memorial Institute under contract with the Office of Saline Water. The report, by F. W. Fink (*8*), was based on discussions with marine experts as well as on a review of current literature, such as the recent article by Bruce (*9*), entitled "Five years of experience with desalinization at Morro Bay."

From the standpoint of corrosion, it was concluded that steel probably could be used in handling deaerated sea water at temperatures up to about 250°F. However, detailed information on the corrosion behavior of inexpensive metals, such as steel, in hot water is not yet available. Aluminum-clad aluminum alloys also show promise for processing hot sea water where it is not convenient to employ deaeration. It appears that the upper temperature limit may be lower for aluminum than for steel. In order to justify inexpensive construction, the lifetime or corrosion resistance of the plant must be known in order to properly amortize the capital investment.

Metals such as cupronickels, Monel, Inconel, Hastelloy C, and titanium may have application in processing hot sea water in spite of their high cost. Available information indicates that titanium is the most remarkable of this group. It can be used in handling sea water at temperatures up to the critical point. At ambient temperatures it can resist velocities of 20 to 50 feet per second or more.

Why are we trying so hard to increase the temperature level of our distillation equipment? Thermodynamic analyses do not show necessarily that elevated temperatures are desirable. Tribus *et al.* (*10*) state, "From the point of view of the economy of a process, high temperatures may appear desirable. This statement is true because the capital costs of the irreversibilities introduced to increase plant output are often, in practice, less at elevated temperatures." Another way of looking at it may be this: thermal energy is generally available at elevated temperatures, so more efficient use is made of this energy if our process is designed to operate over the full temperature range. It should be pointed out that each increase in process temperature level carries with it new problems of scale control, construction materials, optimum size of equipment, and so on. Nevertheless, there is no doubt that at the present state of the art there is much to be gained if we can raise the operating temperature to 300°F.

It is generally assumed that if we increase the rate of heat transfer we increase the rate at which vapor is formed and transferred to the condensing surface. This is true, but it does not follow that a design based on a philosophy of optimizing heat transfer will be the same as a design based on optimizing vapor (mass) transfer. To increase heat transfer, studies have been made on forced-circulation, dropwise condensation, rotating heat-transfer surfaces, and wiped-film evaporators. For each increase in performance we have paid a price in increased capital cost

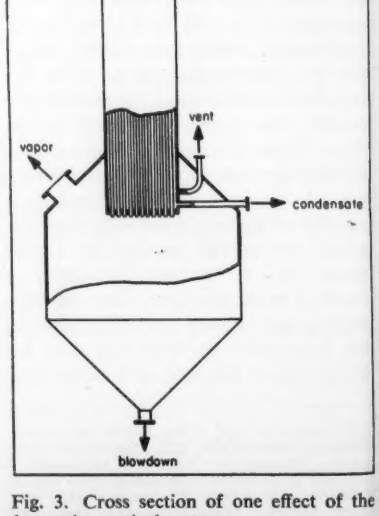


Fig. 3. Cross section of one effect of the long-tube-vertical system.

and generally in operation and maintenance cost. It is our belief that design studies can and should be made to optimize the vapor transfer in distillation equipment.

Conversion Processes

At the inception of the Saline Water Conversion Program (*11*) in 1952, consideration was given to all existing and potential processes or phenomena that might conceivably be used in converting saline water to potable water. Subsequent investigations have reduced the number of processes considered potentially feasible to the point where they may be conveniently classified into four groups: distillation; processes in which membranes are used; freezing; and other types, including chemical, electrical, and biological processes.

Certainly the progress made to date will be highlighted in the demonstration-plant program. The criteria for selection of processes for the demonstration plants included two points worthy of note here. First, the process must be in an advanced stage of development to insure that the number of problems yet to be solved, that can cause long shutdowns, is minimal; second, the process should "look to the future" with respect to energy, materials, and changing conditions.

Distillation. Simple distillation is a long-established method of converting salt water to potable water. Fundamentally, the process is this: the saline water is evaporated in a closed vessel by application of heat, and the water vapor is condensed by being passed over tubes through which cooling water is circulated. Thus, the bulk of the heat needed for evaporation is carried away by the condensing water, and the balance, by the concentrated brine. Such a process requires approximately 1000 times the theoretical minimum energy requirement. There are, of course, more efficient processes than simple single-effect distillation.

Multiple-effect distillation is one method of achieving greater efficiency. A 12-effect distillation cycle was chosen for the first demonstration plant. W. L. Badger Associates, Inc. (*12*), under contract to the Office of Saline Water, has been developing this process over the past several years. It is known as the "long-tube-vertical" (LTV) system. Actually, as originally conceived, in this system the sea water was to have risen in the tubes (2 inches in diameter, 24 feet long, in this design), but tests have shown that a falling-film arrangement inside the tubes gives better heat-transfer rates. The success of this process depends in large measure upon whether or not it can be operated free of scale, and on whether low-cost construction materials can be used.

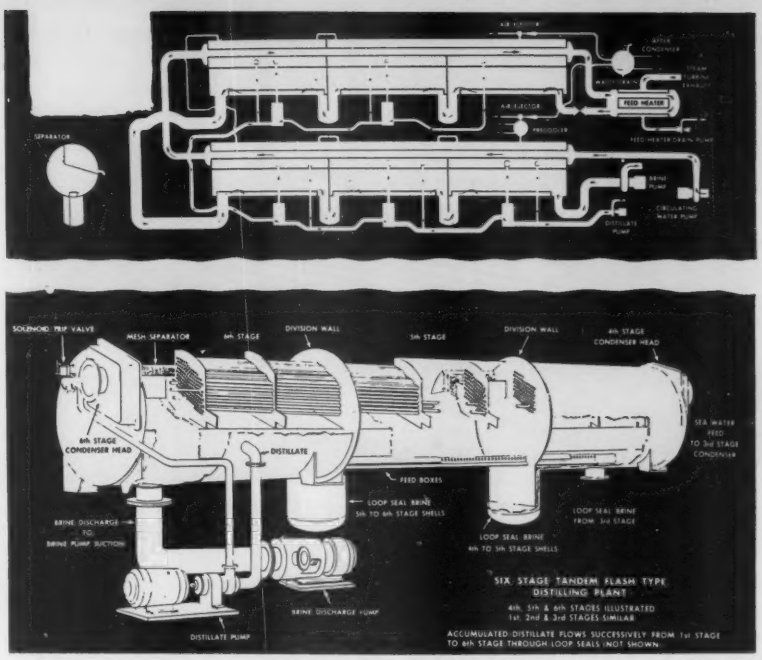


Fig. 4. Cutaway view of a multistage flash evaporating plant, similar to one under test at Wrightsville Beach, North Carolina.

An internal-sludge stabilization technique, common to the salt and chemical industries, has been tested successfully in a pilot plant erected by Badger (*13*) at the International Nickel Company's experimental station at Harbor Island, North Carolina. Calcium carbonate and magnesium hydroxide have been controlled at temperatures up to 250°F. The Chicago Bridge and Iron Company constructed the 1-million-gallon-per-day plant at Freeport, Texas, to demonstrate this process, and it began operating in June 1961. Figure 3 is a typical cross section of one of the 12 LTV, falling-film evaporators, in which the sea water falls, by gravity, down the inside of the tubes and the steam (vapor) from the previous effect condenses on the outside, forming the product water.

In flash distillation the term *multistage* is used, rather than *multieffect*. Use of the word *stage* instead of *effect* apparently is to differentiate between the case where the sea water is heated under pressure prior to entering a series of flash chambers or stages and the case where the vapor from one effect is used to boil water in the next effect.

An excellent discussion of the reasons for the increased use of this process for sea-water distillation was published by A. Frankel (*14*). The first problem to delay the development of flash equipment was the formation of scale on heat-transfer surfaces. In a submerged coil unit, scale formation results in a reduction of output, while in the flash evaporator it causes not only a reduction in output but also a reduction in the specific heat consumption, as well as appreciable change in the flow resistance of the brine circulating system. According to present practice, these plants are operated at less than atmospheric pressure, and effective scale control has been achieved at 200°F with chemical feed treatments, such as Hagevap LP. Furthermore, on the basis of tests conducted by the Griscom-Russell Company for the Office of Saline Water, it is believed that sludge recirculation will prove as effective for multistage flash distillation as it has for the LTV, falling-film process, in which case the temperature level of operation can be raised to 250°F. The type of plant being tested by Griscom-Russell is shown in Fig. 4. The San Diego plant will be designed to test the same conditions on a larger scale.

The Fluor Corporation of Los An-

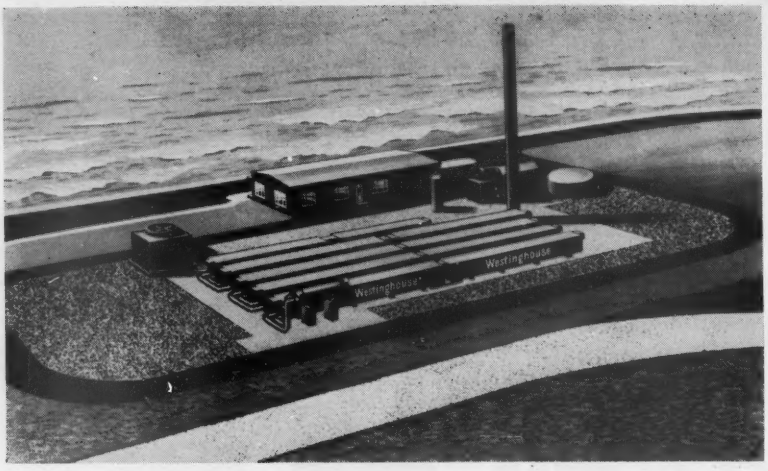


Fig. 5. Artist's conception of the flash evaporator plant to be built at Point Loma, San Diego, California.

geles is supplying the architectural and engineering services for the 1-million-gallon-per-day, multistage flash-process demonstration plant at San Diego, California. The Westinghouse Electric Corporation will construct the 36-stage plant. Groundbreaking ceremonies were conducted 19 December 1960.

Initially it was planned to combine a low-temperature nuclear reactor with the San Diego plant. Because of the experimental nature of this reactor, however, approval for it was never obtained. Therefore, the plant will get its energy from an oil-fired steam generator. Thus, this combination will not "look to the future" to the extent originally planned, but it will probably be the most reliable of the demonstration plants and, as such, will be hard to beat in this five-plant race to produce desalinized water economically. Figure 5 is an artist's sketch of the plant to be built in San Diego.

The vapor-compression process has been known for many years to be the most thermally efficient process, but it was not until World War II that the need for a "self-contained" unit was such that satisfactory units were developed. The best available combinations of engine, compressor, evaporator, pump, and heat exchanger have proved themselves in service. For a time, though, enthusiasm waned because it was apparent that scaling of the evaporator tubes was a serious problem.

However, the Office of Saline Water continued to support studies by Bliss (*15*) and by Dodge and Eshaya (*16*) on a forced-circulation vapor-compression process. This work was a factor in the decision to demonstrate this process at Roswell, New Mexico, in a plant with a capacity of 1 million gallons per day. The Catalytic Construction Company of Philadelphia is at work on the architectural and engineering specifications for this plant. The principal problem here, as in any distillation process, is that of scale control. A typical analysis of the saline well water at Roswell is given in Table 1.

This water, as compared with sea water, is high in sulfate. This highlights a problem which is not generally appreciated—that often it is more difficult to control scale in handling brackish inland waters than in handling sea water.

The choice of forced-circulation instead of thermal circulation in this process is based on data which indicate that it is easier to control scale in a forced-circulation system. In order for this process to succeed, scale must be controlled. It is hoped that as more is learned about sludge recirculation, and as these techniques are successfully applied to calcium sulfate, the forced-circulation, vapor-compression process will demonstrate the advantage of its low energy requirement and will be competitive on a unit-price basis. However, in this first plant, ion-exchange equipment will probably be specified in order to remove the calcium and magnesium. The largest existing vapor-compression installation was built by the Cleaver-Brooks Corporation for Kindley Air Force Base in Bermuda. This plant has a capacity of 200,000 gallons per day. The capacity of the Roswell plant will probably be 1 million gallons per day; thus, it will be the largest vapor-compression distillation installation ever built.

Electrodialysis. In recent years probably more has been written about the application to saline-water conversion of the electrodialysis process than has been written about any other single process. Ellis's book *Fresh Water from the Oceans* (*17*) was criticized because of its undue emphasis on this process. A timely book entitled *Demineralization by Electrodialysis* has been published recently by the staff of the Process Development Division, National Chemical Research Laboratory of Pretoria, Union of South Africa (*18*).

A more condensed discussion is presented by H. J. Cohan (*19*) of the Bureau of Reclamation, in Denver. He concluded that although the electrodialysis process has been known for a very long time, intensive developmental work to change the process from a laboratory curiosity to a practical large-scale operation has been done only in the last few years. The full potential of this process has not been realized, and will not be realized until cheaper membranes, improved flow-compartment configurations, more effective methods of scale prevention, and methods of further reducing the hazards of polarization are developed.

The Bureau of Reclamation is serving as the architectural and engineering organization for the 250,000-gallon-per-day electrodialysis plant to be built at Webster, South Dakota.

Figure 6 is a simplified schematic diagram of this process. Since the presence of manganese in the Webster well water would damage the electrodialysis membrane, the manganese will be oxidized by aeration and injection of potassium permanganate, then removed in the manganese-zeolite tanks before the stream enters the electrodialysis stack.

In the electrodialysis process, power consumption is a function of demineralization, and thus potable water, meeting health standards for salinity of 500 parts per million, can be produced from saline water containing 2000 to 3000 parts per million at a saving in energy over the distillation process. It is believed that the criterion of "a look to the future" is fully met by the electrodialysis process. The Webster plant is to be constructed by the Asahi Chemical Industry Company, Ltd., in cooperation with the Austin Engineering Company. This plant will be used to de-

mineralize brackish well water containing 1800 parts of dissolved solids per million parts of solution, reducing its content of dissolved solids to 500 parts per million.

Freezing processes. Theoretically, a single freezing should produce potable water from sea water. However, ice formed from saline solution occludes or entraps brine between the interstices of the ice crystallites, and some brine is also adsorbed on their surfaces. Thus, one of the major problems that had to be solved before this process could be considered feasible was the development of satisfactory methods of separating the ice crystals from the mother liquor. Research sponsored by the Office of Saline Water and the work of others has shown that several separation procedures are technically feasible, and at this time at least one is economically feasible.

The fifth conversion plant, to be built on the East Coast, at Wrightsville Beach, North Carolina, will use a direct-freezing process. The specific type of direct-freezing process has not been chosen at this time, but research and development work now in progress should soon lead to a decision. The experimental programs of Carrier Corporation, Blaw-Knox, Cornell University, and Struthers-Wells–Scientific Design are continuing, and experimental work is reported in Israel and Japan. At present a number of Office of Saline Water reports (*20*) are available, as well as recent publications by Bosworth, Barduhn, and Sandell (*21*) and by Karnofsky (*22*).

Table 1. Analysis of saline well water at Roswell, New Mexico.

Solids	Concentration (ppm)
Sodium	7,452
Calcium	673
Magnesium	587
Iron	Trace
Chloride	12,606
Sulfate	2,838
Silica	Trace
Ca ("hardness") as $CaCO_3$	2,320
Mg ("hardness") as $CaCO_3$	824
Total dissolved solids*	24,360

* *p*H, 7.4.

The Carrier Corporation, under contract to the Office of Saline Water, has designed, erected, and put into operation a 15,000-gallon-per-day pilot plant, using a direct-freezing, vapor-absorption system. The initial plant installation, at Syracuse, New York, used artificially produced sodium chloride feed water with the same total saline content as sea water. The installation had good operating runs and produced water with an average salinity of less than 500 parts per million. The plant then was moved to Harbor Island, North Carolina, and operation started again on 31 October 1960. After preliminary tests, a continuous run of 500 hours was made on raw sea water to demonstrate the reliability of the design.

Other processes. Various phenomena and techniques relating to potential conversion processes or associated problems are being investigated. These studies range from effects of impressed electrostatic fields on the salt water–air interface, through commercial utilization of certain elements in sea water and the development of improved membranes, to the use of acoustical energy in an attempt to improve the economy of evaporator operation.

Heat transfer between immiscible liquids has been proposed by Woodward (*23*) as an efficient, scale-free method of raising the temperature of the feed sea water in a distillation process. The idea of using immiscible liquids in a solvent extraction process has also been studied in some detail by Hood and Davison (*24*) of the Department of Oceanography of the Texas A & M Research Foundation.

The feasibility of demineralizing water with a pair of electrodes, one responsive to the cation and the other to the anion, has been demonstrated by

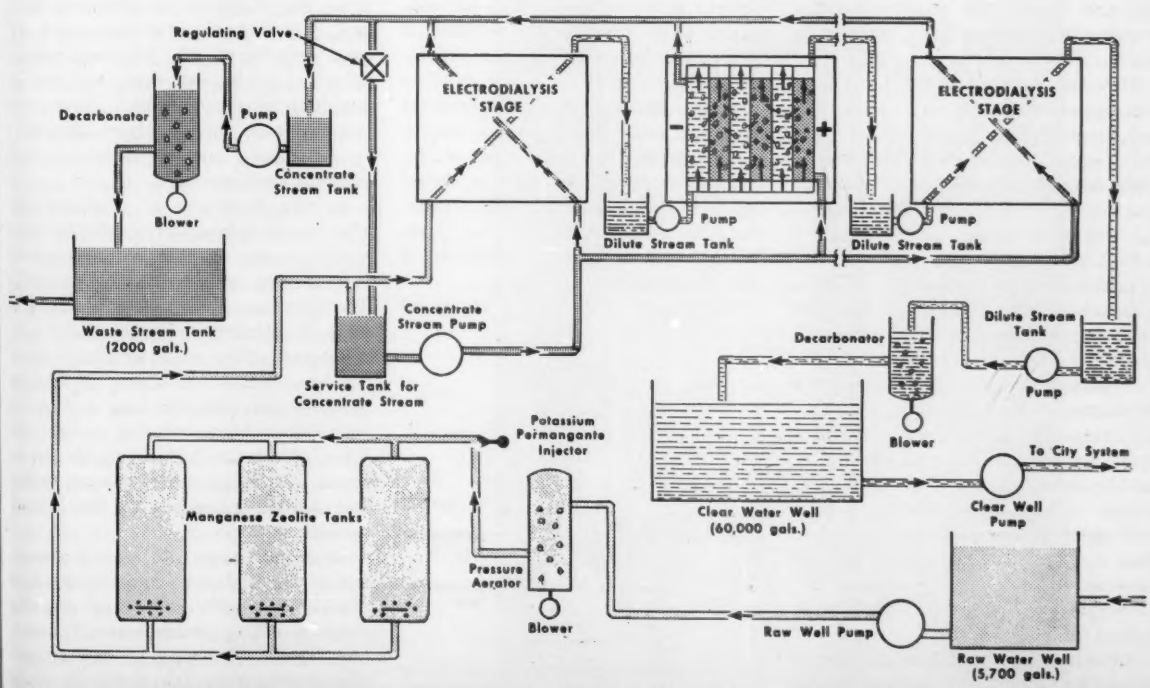


Fig. 6. Schematic diagram of the electrodialysis plant (capacity 250,000 gallons per day) to be built at Webster, South Dakota.

Table 2. Summary of estimated conversion costs (per 1000 gallons) for various processes.

Process	Estimated conversion cost ($)			
	Based on operating plants		For plant producing 1 million gal/day (1960)	For plants producing 10 million gal/day (1965)
	1950	1955		
Sea water				
Multiple-effect flash distillation	3–4.00	1.80–2.50	1.18	0.60
Vapor-compression distillation	3–5.00	1.54–3.00	1.75	1.00
Long-tube-vertical, multiple-effect evaporation			1.00	0.60
Direct-freeze, flash evaporation			1.00+	0.60
Brackish water				
Electrodialysis				
Total dissolved solids, 4000 ppm	1.30		1.00	0.50
Total dissolved solids, 2000 ppm	1.10		0.60	0.30

Murphy (*25*). Most commercial carbons exhibit varying degrees of cation responsivity, and the electrochemical cation capacity can be increased by treating carbons with oxidizing acids. Such carbons have capacities, per gram, of the same order as synthetic ion-exchange resins. It has also been found possible to treat carbons chemically and confer anion-responsivity on them. Preliminary cost estimates for this process indicate that it is economically feasible.

A Look to the Future

One thing is certain: when the data from the demonstration-plant program become available, we will have taken a big step toward the solution of the problem of obtaining fresh water from the sea.

However, in spite of this heartening fact, scientists and engineers do not see any possibility of a major breakthrough from operation of these five plants. Only through continued basic research can man hope to approach the theoretical minimum energy requirement of 2.89 kilowatt-hours per 1000 gallons, as calculated by Murphy (*26*). Theoreticians will immediately point out that there are inherent thermodynamic irreversibilities not included in this figure, and that a minimum of about four times this figure is all we can hope for. This still leaves plenty of room for improvement, for processes in operation today require many times this amount of energy. It is predicted that, as research and development continue along the lines discussed here, a practical limit of between 30 and 70 kilowatt-hours per 1000 gallons of demineralized water will be reached.

Even if energy were free, the cost of converting water with present equipment might still be too high. If a cheaper source of energy is found, then the emphasis in design will shift to minimizing the capital cost of the equipment as well as the cost of operation and maintenance. In the early days of the Office of Saline Water some study was made of the use of wave energy, tidal energy, wind power, atmospheric heat, and so on. The applications of solar energy and geothermal energy to the demineralization of saline waters has received some attention, but at present the capital cost of equipment to utilize these diffuse sources appears to be too great.

A current study is being made for the Office of Saline Water by Chance Vought Corporation (*27*), on the economic feasibility of utilizing radioisotopes as a source of energy for converting saline water to fresh water. It appears that the most economical radioactive source material is the calcined rare-earth fission-product cut resulting from the processing of spent reactor fuel elements. Since the cost of this material is practically zero, it should prove to be competitive with conventional fuels as a source of heat if the costs of processing and transporting it can be kept low.

Radioactive wastes are a long-lived source of heat, and of heat in predictable amounts in that the emission of energy follows certain mathematical relationships. Use of such wastes simplifies fuel logistics problems by providing energy for long periods of time with only one fuel loading. The source itself is simple in character in that the energy may be transferred to the saline water directly, without use of intermediate heat exchangers or fluids.

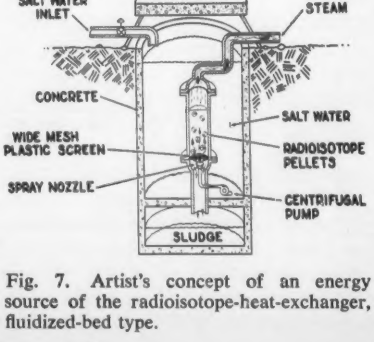


Fig. 7. Artist's concept of an energy source of the radioisotope-heat-exchanger, fluidized-bed type.

Two approaches are being pursued in the development of this energy source. The first is based on the concept of a fluidized bed in which the influent saline water is used to fluidize encapsulated radioactive pellets. The effluent from this process may be either steam or pressurized water, both being in a form suitable for supplying energy to saline-water-conversion equipment. Figure 7 illustrates the concept of an energy source of the fluidized-bed type. The other approach is that of placing the calcined radioactive-waste material in fuel rods. This approach is probably best suited for use in an indirect-cycle plant where an intermediate, nonscaling heat-transfer medium is used to transfer the energy to a conversion process such as multistage flash.

Concurrent analytical studies are being conducted on the rod and pellet configurations. The objective of these studies is to determine the optimum size and configuration of the rod or pellet array and of the heater vessel for various operating requirements, such as inlet conditions of the feed, fluid velocity, production rate, and outlet condition of the effluents. These analytical studies include thermodynamic, fluid dynamic, nuclear, structural, and chemical considerations.

In any discussion of processes the observation is invariably made that certainly reverse osmosis is the simplest, if it can just be made to work reliably. The term *osmosis* is used to describe a class of phenomena where there is a spontaneous flow of water into a solution, or from a more dilute to a more concentrated solution separated from each other by a suitable membrane. Thus, if we can find a suitable membrane we can pressurize the sea water and achieve a reversal of the normal osmotic flow.

Reid and Breton (*28*) tested a number of materials and came to the conclusion that cellulose acetate was the most promising of commercially available films. This project was discontinued when it was shown that the durability and flow rate of the membranes

had to be improved before the process could compete economically with other processes. The Office of Saline Water then sponsored a basic research project with Radiation Applications, Inc. (*29*), in an effort to demonstrate the feasibility of modifying existing membrane materials both by use of nuclear radiation and by chemical means. Although the flow rates and the membrane longevity achieved to date have been lower than those required for a practical water desalination unit, the validity of the particular approach to the membrane-preparation problem has been demonstrated. Another research contract was executed with the Monsanto Research Corporation (*30*), to study the mechanism of water transmission through polymer films and to develop information which might make it possible to predict what structural and functional groups would give increased permeability and selectivity. Preliminary investigations indicate that polymeric films with appropriate micropores and selective crosslinking may meet the requirements of high water permeation, low salt transmission, and physical and chemical stability.

Loeb and Sourirajan (*31*) have been working independently at the University of California, Los Angeles, and have found that by mixing cellulose acetate with aqueous magnesium perchlorate solution and acetone, and then casting the sticky mixture cold on a glass plate, they are able to make a membrane of considerably longer life than any other yet developed. It is believed that the technique of shrinking the membrane to control pore size was the unique contribution of this project. A unit is being built, based on test data that indicate a rate of demineralization of 8 gallons per square foot per day.

The osmionic process, conceived and studied on a laboratory scale by G. W. Murphy, makes use of the driving force due to differences in concentration of brine and of the water to be demineralized. The promise of the process lies in the fact that the brine may be either natural brine or brine obtained by evaporating saline water. The sun would serve as the primary source of energy for the evaporation process. In contrast to conventional solar-energy conversion devices, no expensive fabricated structure is necessary to collect the sun's energy. No other energy source is needed, except for pumping the solutions.

The Southern Research Institute (*32*) has developed a bench-scale model of an osmionic demineralizer, shown in Fig. 8. Realization of the potentialities of this process will probably have to await development of cheaper and more selective electrodialysis membranes. With membranes currently available it has been found that promising rates of demineralization of sodium chloride solutions are obtained with the demineralizer, but that it is slightly less effective in treating solutions containing divalent ions. The bench-scale unit has contributed not only to membrane evaluation but to improvement of the mechanical design, by making it possible to determine the optimum spacing between membranes and the effect of different flow velocities in the compartments.

One of the most recently investigated methods of demineralizing sea water is one in which pure water is separated out as a solid gas hydrate. Very briefly the process is this: Any aqueous solution is brought into contact with an agent (*M*), such as a light hydrocarbon or a halogenated derivative, to form a solid substance of the formula $M \cdot nH_2O$. This solid is a pure crystal and contains none of the constituents of the aqueous solution except the water in its lattice. One may then separate the crystals from the adhering brine and melt them, to recover the water as a product and to recover the agent for recycling to the process.

The hydrate system for desalting has many potential advantages over other methods. It is really a chemical process but is similar in some respects to a freezing process, except that the separated solid is a hydrate rather than ice. Thus, it has most of the advantages of the freezing process, such as a low energy requirement, no scale, and no membranes. It has an additional advantage over freezing processes in that it can be operated at temperatures substantially above those at which ice forms in sea water—that is, about 25° to 26°F. Depending on the hydrating agent used, the temperature may be as high as 50° to 60° thus, considerably improving the performance of the refrigeration equipment over that obtained in freezing processes.

The choice of the best hydrating agent for desalting water is based on several factors in addition to formation temperatures and pressures. The most important of these additional factors are the rate of formation of the hydrate,

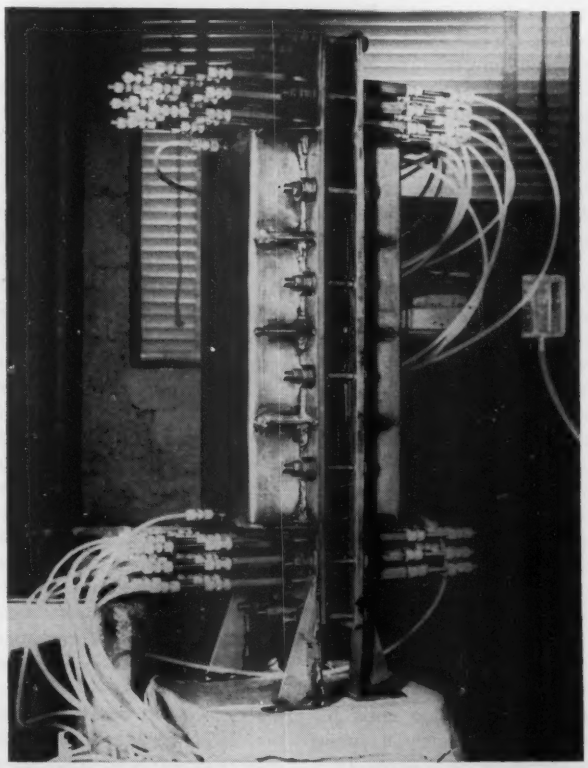


Fig. 8. Bench-scale model of an osmionic demineralizer.

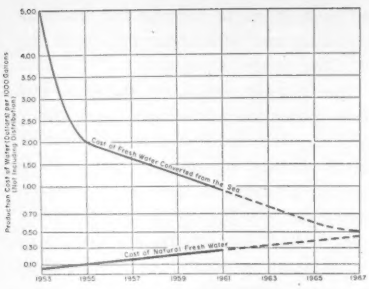


Fig. 9. Trends in the cost of developing new sources of natural and desalinized water.

the nature of the hydrate crystals, and the solubility of the agent in water. The first of these determines the size and general design of the reactor. The second determines ease of pumping a slurry of hydrate crystals and ease of washing them free of brine. The third affects the kinetics and determines the system that is needed to recover the agent from the effluent brine and fresh water.

Basic work on hydrating agents and their thermodynamic properties is being done by Barduhn, Towlson, and Hu (*33*) of Syracuse University, under contract with the Office of Saline Water. The engineering aspects of a propane system are being investigated by the Koppers Company (*34*).

This "look to the future" would not be complete without some comment on distillation. A number of new designs are being developed. Some are based on the assumption that to increase the rate of heat transfer will lead to greater efficiency. Others are based on the belief that a significant increase in rate of condensation will result in a more economical unit. The question of optimum design for distillation equipment will remain with us for some time, and improvements will probably continue to bring the cost down. However, the most convincing demonstration of progress will be the building of a plant with a capacity of the order of 50 million gallons per day, producing fresh water at a cost of 50 cents per 1000 gallons.

Costs

The estimated conversion costs for several processes and potential future costs were discussed by Gillam (*35*) at the February 1960 meeting of the American Institute of Mining, Metallurgical, and Petroleum Engineers in New York. Table 2 lists estimates that are based on data available from operating conversion equipment, or from pilot-plant studies, and anticipated future costs after the incorporation of certain modifications, as estimated from detailed engineering analyses. Such modifications might include an increase in capacity, improved heat-transfer rates, use of less expensive construction materials, alleviation of scale formation, and improved membranes.

As shown in Table 2, in 1950 cost estimates for sea-water conversion ranged up to $5 per 1000 gallons. Improved processes and equipment developed during the subsequent 5 years reduced the figure to around $2 per 1000 gallons. At the present time, additional improvements in certain distillation processes and the development of freezing processes appear to justify projection of a cost of $1 per 1000 gallons. It appears quite likely that future conversion costs for large installations will be considerably less than $1 per 1000 gallons.

A final point is one made by T. B. Noland, director of the U.S. Geological Survey, speaking at the Fourth National Watershed Congress. According to Noland, we can say emphatically that we will have water to meet our needs, except for irrigation needs in arid or subhumid regions, in the immediate future, but we can say with equal emphasis that there is not the slightest possibility that we can obtain new supplies of water at the cost of the water we use today. "This is not a matter of inflation," said Noland, "it is the law of diminishing returns. In resource development, the best and cheapest sites are utilized first, so inevitably increased use is accompanied by increased cost."

This point is made graphically in Fig. 9, which gives a comparison of costs of natural fresh water and fresh water from converted sea water. Already a few localities have found that these curves cross, or that the margin has become so narrow that the need for a dependable source has caused them to look to the sea. An economic analysis should be made for each site that is considering conversion of saline water. An article by A. W. Bruce (*36*) on the decision to install sea-water evaporators at the Morro Bay Steam Plant in California is a study of the type suggested.

References

1. L. B. Johnson, "If we could take the salt out of water," New York *Times* (30 Oct. 1960); R. S. Kerr, *Land, Wood, Water* (Fleet, New York, 1960).
2. "Research needs for salt water conversion," *Publ. Committee on Science and Astronautics, U.S. House of Representatives, 87th Congress* (Government Printing Office, Washington, D.C., 1961).
3. *Survey on Institutions Engaged in Research on Saline Water Conversion* (UNESCO, New York, 1958).
4. W. F. Langelier, D. H. Caldwell, W. B. Lawrence, *Ind. Eng. Chem.* **42**, 126 (1950).
5. J. T. Banchero and K. F. Gordon, *Advances in Chem Ser.* **27**, 105 (1960).
6. K. K. Kelley, J. C. Southard, C. T. Anderson, *U.S. Bur. Mines Tech. Papers No. 625* (1941).
7. J. L. Chandler, thesis, University College of the West Indies (1959).
8. F. W. Fink, *U.S. Dept. Commerce, Office Tech. Serv. Rept. No. PB 171,344* (1961).
9. A. W. Bruce, *J. Am. Water Works Assoc.* **53**, 11 (1961).
10. M. Tribus, R. Asimow, N. A. Richardson, C. Gastaldo, K. Elliot, J. Chambers, R. Evans, *Univ. Calif. (Los Angeles) Publs. Eng. Rept. No. 59-34* (1960).
11. O. L. Chapman, G. W. Lineweaver, D. S. Jenkins, "Demineralization of saline waters," *U.S. Dept. Interior Rept.* (1952).
12. W. L. Badger and F. C. Standiford, *Natl. Acad. Sci.–Natl. Research Council Publ. No. 568* (1957), pp. 103–114.
13. W. L. Badger, *U.S. Dept. Commerce, Office Tech. Serv. Rept. No. PB 161,290* (1959).
14. A. Frankel, *Proc. Inst. Mech. Eng. (London)* **174**, No. 7 (1960).
15. H. Bliss, *U.S. Dept. Commerce, Office Tech. Serv. Rept. No. PB 161,383* (1955).
16. B. F. Dodge and A. M. Eshaya, *U.S. Dept. Commerce, Office Tech. Serv. Rept. No. PB 161,395* (1958); B. F. Dodge, *Am. Scientist* **48**, 476 (1960).
17. C. B. Ellis, *Fresh Water from the Ocean* (Ronald Press, New York, 1954).
18. J. R. Wilson, Ed. *Demineralization by Electrodialysis* (Butterworths, London, 1960).
19. H. J. Cohan, *Chem. Eng. Progr.* **57**, 72 (1961).
20. C. M. Bosworth, S. S. Carfagno, D. J. Sandell, *U.S. Dept. Commerce, Office Tech. Serv. Rept. No. PB 161,397* (1959); C. M. Bosworth, S. S. Carfagno, A. J. Barduhn, D. J. Sandell, *U.S. Dept. Commerce, Office Tech. Serv. Rept. No. PB 161,403* (1959); G. Karnofsky and P. E. Steinhoff, *U.S. Dept. Commerce, Office Tech. Serv. Rept. No. PB 161,819* (1960); H. F. Wiegandt, *U.S. Dept. Commerce, Office Tech. Serv. Rept. No. PB 161,906* (1960).
21. C. M. Bosworth, A. J. Barduhn, D. J. Sandell, *Advances in Chem. Ser.* **27**, 90 (1960).
22. G. Karnofsky, *Chem. Eng. Progr.* **57**, 42 (1961).
23. T. Woodward, *ibid.* **57**, 52 (1961).
24. D. W. Hood and R. R. Davison, *Advances in Chem. Ser.* **27**, 40 (1960).
25. G. Murphy *et al.*, *U.S. Dept. Commerce, Office Tech. Serv. Rept. No. PB 171,129* (1960).
26. G. Murphy, *U.S. Dept. Commerce, Office Tech. Serv. Rept. No. PB 161,384* (1956).
27. G. R. Armstrong and M. A. Welt, paper presented before the American Institute of Electrical Engineers, New York (1961).
28. E. J. Breton, *U.S. Dept. Commerce, Office Tech. Serv. Rept. No. PB 161,391* (1957).
29. *U.S. Dept. Interior, Saline Water Conversion Rept. for 1959* (1960), p. 21.
30. *U.S. Dept. Interior, Saline Water Conversion Rept. for 1960* (1961).
31. S. Loeb and S. Sourirajan, *Chem. Eng. News* **38**, 64 (11 Apr. 1960).
32. R. E. Lacey, E. W. Lang, C. E. Feazel, *U.S. Dept. Commerce, Office Tech. Serv. Rept. No. PB 161,862* (1960).
33. A. J. Barduhn, H. E. Towlson, Y. Hu, *U.S. Dept. Commerce, Office Tech. Serv. Rept. No. PB 171,031* (1960).
34. W. G. Knox, M. Hess, G. E. Jones, Jr., H. B. Smith, Jr., *Chem. Eng. Progr.* **57**, 66 (1961).
35. W. S. Gillam, *Am. Inst. Mining Met. Petrol. Engrs. Tech. Paper No. 60H14* (1960).
36. A. W. Bruce, *Combustion* **26**, 65 (1954).

Olfactory Stimuli in Mammalian Reproduction

Odor excites neurohumoral responses affecting oestrus, pseudopregnancy, and pregnancy in the mouse.

A. S. Parkes and H. M. Bruce

Almost all vertebrates are equipped with visual, olfactory, and auditory perception, but there is wide variation in the extent to which animals of different groups rely on the different senses for contact with their environment, and in the extent to which their lives are influenced by specific sensory stimuli. Among the higher vertebrates an instructive comparison can be made between birds and mammals. In most species of birds the sense of smell is poorly developed, and vision plays a major part in social and other responses. There are notable exceptions to this generalization, as was recently emphasized by Bang (*1*), but generally it is true that vision is far more significant in the life of birds than olfaction; in particular, visual stimuli are potent exteroceptive factors in the reproductive processes of birds, whereas olfactory stimuli are not known to have such a role. In mammals the situation is reversed. Many mammals have indifferent vision, especially color vision, and most depend more on smell than on sight to assess their environment; light and dark appear to be the only purely visual stimuli known normally to act as exteroceptive factors in mammalian reproduction. By contrast, smell is a potent factor in mammalian social life, and the odorous substances produced by mammals are implicated, as shown by well-authenticated observations, not merely in defense, territory marking, and identification but also in sex attraction and the evocation of sexual and aggressive behavior. Thus, Kelley (*2*) observed that the pregnant ewe, which is unattractive to the ram, could be made attractive by smearing her vulva and perineum with a swab taken from the vagina of an oestrous ewe. Interest in this field is age-old, as witness the traditional use of musk, civet, and castoreum (from the beaver) in high-quality perfumes. Whether there are interspecific effects of sex attractants, other than the conditioning of reflexes, may be doubted, but the intraspecific effects are well established.

Direct neural effects, however, are not the only ones evoked in mammals by odor. In the last few years evidence has accumulated that odor can constitute an exteroceptive factor affecting the oestrous cycle and pregnancy, and that in doing so it acts through neurohumoral mechanisms analogous to those evoked by visual stimuli in birds and by light and dark in certain mammals. The recognition of odor as an exteroceptive factor of this kind in mammals is comparatively new and is likely to open up a wide field of investigation. In this article we review the relevant evidence and discuss its wider biological implications.

Social Effects on Reproduction in Mice

Interaction between female mice (Lee-Boot effect). It is often assumed that the oestrous cycle in the mouse is spontaneous and regular until senescence, only being interrupted from time to time by pregnancy (or pseudopregnancy) and lactation. Recent observations, however, have shown that this traditional concept is far from complete, for it is now recognized that the oestrous cycle of the female is profoundly influenced by her social environment. These effects are produced by means of neurohumoral mechanisms for which the primary—perhaps the sole—stimulus is olfactory.

The earliest report of such a reaction came from workers in Holland, who found that when female mice were housed together in groups of four there was an increase in the number of spontaneous pseudopregnancies, which occurred in up to 25 percent of all cycles (*3*). That true pseudopregnancies rather than short periods of anoestrus were involved was shown by the fact that the formation of deciduomata was possible during the longer cycles induced by females in each other. The effect could be prevented by excision of the olfactory bulbs, or by housing the females individually (*4*). The prolonged cycles were apparently not dependent on physical contact between the females (*5*), although Dewar (*6*) observed male mating activities (chasing and mounting) between oestrous females in his colony and suggested that such behavior might have been a contributory factor.

Another type of interaction was observed when female mice were housed in larger groups of 30 per box; the oestrous cycles became highly irregular, and the majority of the mice became anoestrous for long periods. The reaction, however, was readily reversible, and over 90 percent of such females mated within 5 days of being paired with a stud male (*7*). Thus, it appears that the grouping together of female mice leads to mutual disturbance of oestrous cycles, by the intervention of pseudopregnancies if the groups are small or of anoestrus if the groups are large.

Effect of the male on the oestrous cycle (Whitten effect). At about the same time that these observations were made, Whitten (*8*) drew attention to the unexepected pattern of mating behavior among females housed in groups before being paired. He found that mating did not take place with approximately equal frequency on the first four nights after pairing, as it does in females which have been housed individually before the introduction of the male (*9*). Fewer females than had been expected mated on the first, second, and fourth nights, but mating on the third night greatly exceeded expectation, amounting, in the experiments reported, to 46 percent of the matings for all females paired, or to over 50 percent of the matings for females that mated within 4 days (Fig. 1). This reaction, also, was independent of contact between individuals. When the

Dr. Parkes is head of the Division of Experimental Biology, National Institute for Medical Research, London; Dr. Bruce is a member of the division.

Table 1. Interactions between two strains in pregnancy block (23 or more females per group).

Stud ♂	Stud ♀	Strange or alien ♂	Blocked pregnancies (%) ○ ● P/CBA	Blocked pregnancies (%) ○ ● P/Dutch
♂	♀	♂	25	25
		●	81	78
●	♀	●	16	30
		♂	88	87
♂	●	♂	31	32
		●	78	84
●	●	●	*	48
		♂	52	88

*Not tested.

male was confined in a wire basket in the box containing the female for 2 days before being released, the peak mating occurred on the first night after his release—that is, as before, on the third night after exposure. Among such females, therefore, a new cycle had been initiated by the introduction of the caged male, so that oestrus was synchronized in the same way as by contact with the male.

It was also found that if a male was confined within a stock box containing 30 females, the oestrous cycle was shorter and more regular than it was in his absence and the incidence of abnormal cycles was reduced (*9, 10*). From his experiments Whitten concluded that the effects on the oestrous cycle and on mating behavior were brought about by olfactory stimuli from the males.

Effect of males on pregnancy (Bruce effect). If the newly mated female is removed from the stud male and exposed to other males of the same strain (strange males) and, more particularly, to males of a strain different from that of the stud male (alien males), pregnancy and pseudopregnancy (the expected result of an infertile mating) are both blocked, to a large extent. The female returns to oestrus within 3 to 4 days of exposure, as if coitus had not occurred, and if the strange (or alien) male has access to the female, fertile mating follows. Experiments in which genetically marked male mice were used show that all offspring born after such successive matings were sired by the second male and that, therefore, the original pregnancy from the stud mating was blocked. As in both the Lee-Boot and the Whitten effects, contact between the sexes is not necessary. Pregnancy-block occurs if the newly mated female is caged inside a stock box containing males (*11, 12*).

The female is vulnerable to the influence of males for the first 4 days of pregnancy, day 0 being the day on which the vaginal plug from the stud mating is found. Exposure of the female on day 5 *post coitum*, by which time discrete swellings are apparent in the uterus, is much less effective, and the reaction is virtually abolished by day 6. The response is slow to develop, exposure for at least 2 days being necessary to produce a maximum number of blocked pregnancies, although some females return to oestrus after an exposure of only 12 hours (*13*). Apparently successive pregnancies in a female can be blocked without impairing her subsequent fertility.

Strain Differences

Since alien males have much greater pregnancy-blocking capacity than strange males, strain differences are of particular interest in the block to pregnancy. As the reaction concerns three individuals (stud male, stud female, and strange or alien male), there are eight combinations in which the influence of two strains can be shown. The effect on the incidence of pregnancy block is given in Table 1. The experiment was performed twice, once with a randomly mated ablino strain P and inbred strain CBA mice, and again with the same albino strain in combination with randomly mated Dutch mice, offspring of some purchased from a dealer in 1959.

Irrespective of the strain to which the female belonged, pregnancy was blocked in about 30 percent of the females when the stud male and the second male belonged to the same strain; when they belonged to different strains it was blocked in about 80 percent of the females. The introduction of a third strain into the reaction failed to raise the incidence of blocked pregnancies; in a few tests involving five strains combined in various ways, 52 out of 65 females returned to oestrus within 7 days. Thus it appears that the induction of a blocked pregnancy is determined by the relationship between the males and the differences between them perceived by the female.

Exposure of the female to alien males before mating appeared to blunt somewhat her powers of discrimination. Reexposure to the same alien males after mating resulted in blocked pregnancies in only about 60 percent of the females 22 out of 36), while exposure to strange males of females exposed to alien males before mating resulted in blocked pregnancies in about 40 percent of the females (14 out of 33).

Furthermore, the presence of the stud male with the female largely eliminated the reaction of the female to alien males surrounding the pair. In such circumstances only eight out of 40 females returned to oestrus within 7 days. When the females were returned to the stud males after separation from them

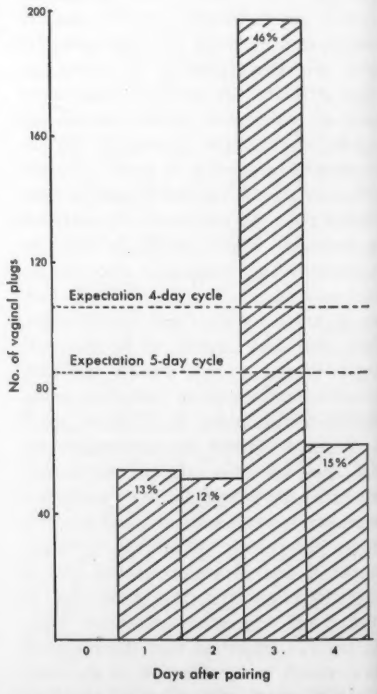


Fig. 1. Incidence of mating over the first 4 days after pairing: 425 females were paired, of which 364 mated within 4 days. [From W. K. Whitten (*8*)]

for 24 hours, none of 46 females returned to oestrus (*12*), 42 females carried the litter to term, and four became pseudopregnant. Thus, not only can the female "recognize" the stud male after separation from him for 24 hours but she can distinguish between males of his strain and males of a different strain; she can also, even without contact, distinguish between strange males and strange females. In the block to pregnancy, the key to this discrimination lies with the stud male.

The fact that pregnancy block is brought about by the proximity of males, and that physical contact with the newly mated females is unnecessary, shows that the effect is mediated by the appearance, sound, or smell of the males. It seemed unlikely for various reasons that sight was implicated, and as the effect is exerted in total darkness, it was felt that the conclusive experiment of blinding female mice was not justified. An investigation of the possible effects of sound was started by making a tape recording of the noises made by the male mice in the test situation, with the idea of subjecting newly mated female mice to repeated playbacks during the 3-day test period. Squeaking and chatterings of possible interest were picked up by the microphone placed among the males, but the main noise recorded was the general and obviously nonspecific pattering of tiny feet. Before the formidable technical difficulties in this experiment could be overcome, another line of work had made it unnecessary.

Whitten (*8*) had shown that the effect of the presence of the male on the oestrous cycle could be reproduced to some extent by placing the females in soiled cages recently vacated by males. Early attempts to bring about pregnancy block by the same method were unsuccessful, but finally the effect was produced in 28 of 33 newly mated female mice by placing them, under conditions of restricted ventilation, in 2-liter glass jars previously occupied by five alien males, on bedding known to retain mouse smell (laboratory coat cloth), and by replacing the jars with other soiled jars twice daily for 3 days (*14*).

Transference of this type of experiment from tall glass jars to ordinary flat mouse boxes showed clearly that the important variable was the twice-daily replacement of the container with a container vacated by males immediately before, rather than the restricted ventilation or the nature of the bedding. Thus, pregnancy was blocked in newly mated females placed individually in boxes vacated by five alien males to the extent of 83 percent and 74 percent, respectively, when the soiled boxes were renewed twice daily over 3-day and 2-day test periods (*15*). These figures are remarkably similar to those for the incidence of pregnancy block in females exposed for 3 or 2 days to the proximity of alien males (*13*). Results almost equally impressive were obtained when the males were allowed to soil sawdust bedding. Renewal of the soiled boxes once daily was much less effective.

The experiments with soiled boxes show that pregnancy block is caused by some substance coming from the males and left behind by them, and the results throw an interesting light on the volatility or instability of the substance. There is a remote possibility that ingestion rather than olfaction is involved. However, the fact that neither pregnancy block (*16*) nor the Lee-Boot and the Whitten effects occur in females rendered anosmic by destruction of the olfactory bulbs seems to establish beyond reasonable doubt that olfactory stimuli are involved.

Consideration of individual and strain differences raises some interesting questions. It is most unlikely that every male mouse produces a different odorous substance. Probably "spectra" of odors are involved, which differ slightly between individuals of the same strain and markedly between certain strains. Even human beings can differentiate between the smells of some strains, as is well recognized by those who work with strains isolated in separate rooms. The differences are less obvious when, as is more often the case, several strains

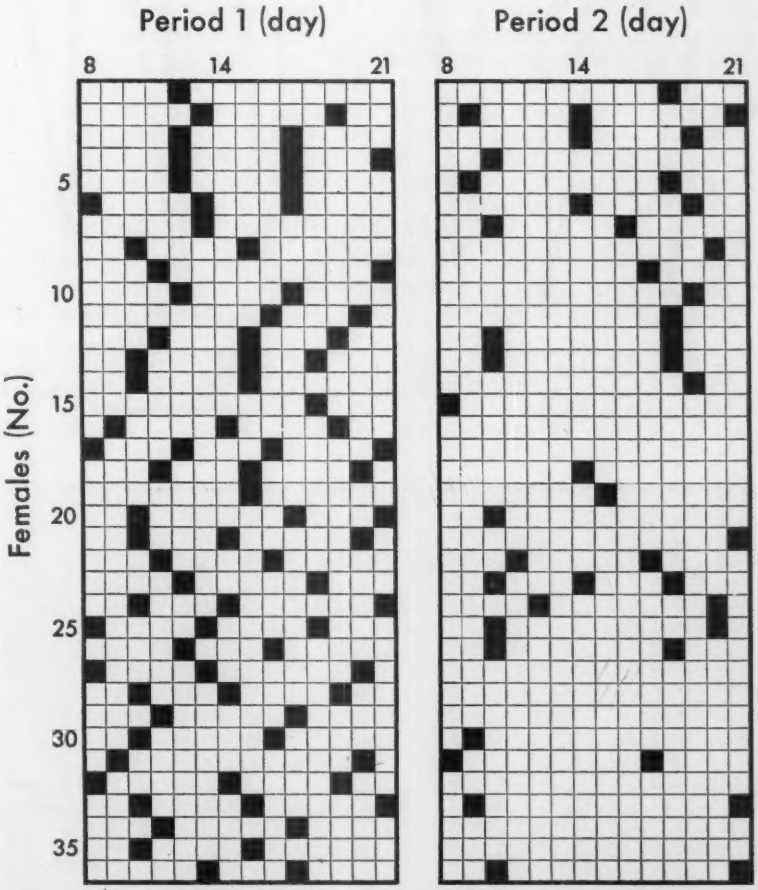


Fig. 2. Effect of the presence of a castrated male on the incidence of oestrus (solid squares). Each horizontal row represents one female. In period 1 (left), females were housed in small groups (two to five) with one castrated male; in period 2 (right), males were removed and all females were housed as a single group in a stock box. One week was allowed for adaptation at the beginning of each period; vaginal smears were examined daily during the second and third weeks.

are kept in one room. There is almost certainly some overlapping of the "spectra" of odoriferous substances contributing to the final effect; it is possible to discriminate more easily between certain strains than between others. In a recent experiment, expert perfumers found that five strains of mice kept at the National Institute for Medical Research fell broadly into two odor groups. In the light of the experiments on strain differences, it is not so much the olfactory acuity as the olfactory memory of the females which is remarkable.

Source of the Male Odor

So far, no information has been obtained as to the source or nature of the operative odor of the male mouse. It is not even certain that all components of the odor spectrum come from the same source. Sexual vigor plays little or no part in pregnancy-blocking capacity. Infertile males completely lacking in sex drive are as effective in inducing the block to pregnancy as are their fertile and more vigorous companions (*12*). Removal of the preputial glands from young adult male mice failed to impair their pregnancy-blocking capacity, 60 out of 81 pregnancies (74 percent) being blocked as compared with 58 out of 76 (76 percent) in concurrent experiments with intact males. Males castrated as young adults retain this capacity to some extent, and experiments now in progress indicate that even when castration is carried out before puberty, the capacity to block pregnancy still develops. Castrated males also produce the Whitten effect (Fig. 2).

The males do not appear to react to the presence of females as regards their output of odorous substances. No difference in pregnancy-blocking capacity of individual groups of males relative to the length of the interval between tests was apparent. Removal of the olfactory lobes does not impair the pregnancy-blocking capacity in the male [50 out of 65 pregnancies (77 percent) were blocked by exposure to anosmic males].

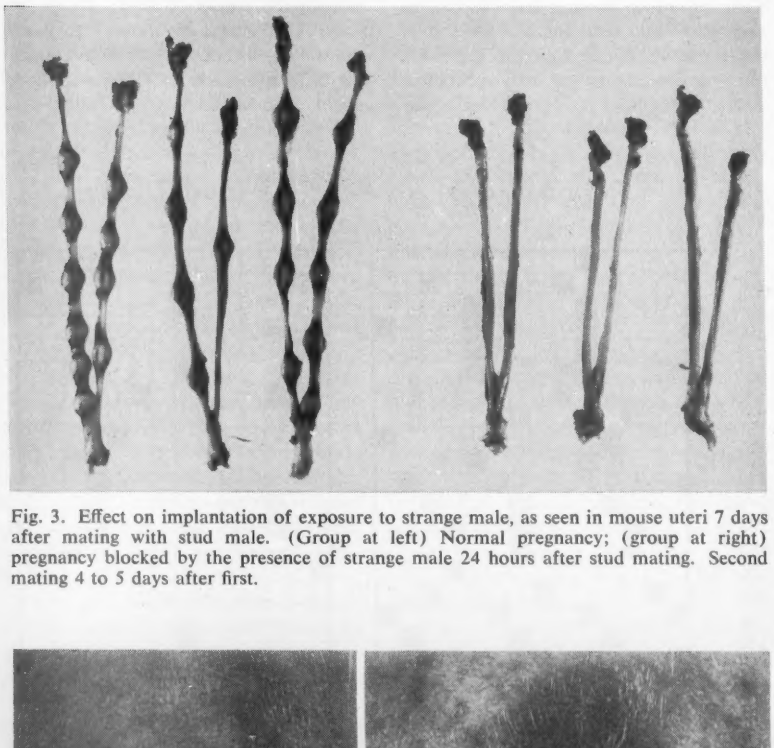


Fig. 3. Effect on implantation of exposure to strange male, as seen in mouse uteri 7 days after mating with stud male. (Group at left) Normal pregnancy; (group at right) pregnancy blocked by the presence of strange male 24 hours after stud mating. Second mating 4 to 5 days after first.

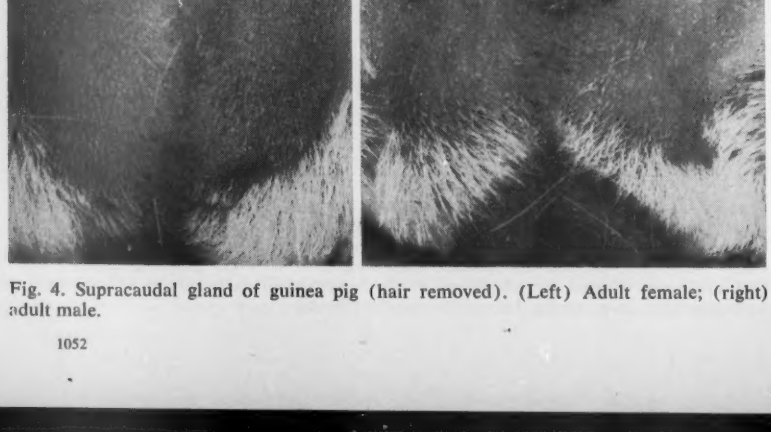


Fig. 4. Supracaudal gland of guinea pig (hair removed). (Left) Adult female; (right) adult male.

Endocrine Factors in Pregnancy Block

The experiments discussed above raise a host of questions about the chain of events by which olfactory stimuli lead to failure of pregnancy and especially about the hormone factors involved. The external symptom of pregnancy block—continuation of the 5-day oestrous cycle as though mating had not occurred—is highly suggestive of failure of the corpora lutea of ovulation to undergo the functional development that would normally occur after mating, with consequent failure of progestational changes in the endometrium and inhibition of implantation. This interpretation accords with the fact that implantation does not take place in a blocked pregnancy (Fig. 3), that the segmented eggs cannot be recovered after they leave the fallopian tube, and that histological examination of the ovaries shows that in many cases the corpora lutea have not developed as they usually do after mating (*12*). The question arises, therefore, as to why development of the corpora lutea does not occur. The effect of the presence of males in interrupting anoestrus of social origin in mice presumably depends on the induction of a flush of follicle-stimulating hormone from the adenohypophysis. Similarly, the effect of the presence of males in interrupting socially induced pseudopregnancy might be due either to a flush of this hormone, terminating pseudopregnancy and actively causing the return of oestrus, or

to a breakdown in the supply of prolactin, which would terminate pseudopregnancy at an early stage and allow the continuation of the normal 5-day cycle.

The possibility that the test situation is sufficiently stressful to excite adrenal complications has also to be considered. In the light of these considerations, experiments were carried out to determine whether pregnancy block could be prevented by the administration of Luteotrophin (prolactin) and whether olfaction-induced pregnancy block could be simulated by the injection of follicle-stimulating hormone or ACTH.

The results were clear-cut. Ten international units of prolactin given daily over the 3-day period during which the females were in the presence of alien males prevented the block to implantation, while block occurred, as usual, in controls (*17*); injection of substantial doses of follicle-stimulating hormone or of ACTH, once, or daily over the usual test period, to newly mated females isolated from males did not produce pregnancy block. It seems, therefore, that the immediate endocrine cause of the block is failure of prolactin secretion by the adenohypophysis, with consequent failure of corpus luteum development and return to oestrus in the ordinary way. This interpretation is confirmed by the fact that pregnancy block on exposure to the presence of males does not occur in lactating mice mated at post-partum oestrus, presumably because of the increased amount of circulating prolactin (*18*). How the failure of prolactin secretion is initiated by the olfactory stimuli is not known, but no doubt the hypothalamus is involved.

The Odoriferous Glands of Mammals

The dramatic effects produced in female mice by odorous substances emanating from the male but of unknown nature and origin raises acute problems about animal odors. The odoriferous glands of mammals differ remarkably in origin and position and in the nature of their products. As Champy (*19*) remarks, they have nothing in common except their odoriferous nature. Anatomically they may be occipital (Arabian camel), suborbital (antelope), on the throat (Californian mastiff bat), scapular (fruit bat), sternal (opossum), lateral (shrew), dorsal (golden hamster), axillary (man), supracaudal (guinea pig) (Fig. 4), interdigital (ruminants), or even scrotal (potto). In mice they have been described on the soles of the feet (*20*) and elsewhere. Probably the best known odoriferous glands in mammals are the anal or perineal glands of the stoat, civet, and other Mustelidae and the preputial glands of the musk deer, the muskrat, and the beaver. A vast amount of information on the location and morphology of the odoriferous glands of mammals is to be found in *Die Hautdrusenorgane der Saugetiere*, by Schaeffer (*21*). Such glands are not, of course, restricted to mammals. The fetid smell of the crocodile, for instance, arises from so-called musk glands in the cloaca. Moreover, specific odorous substances are not only produced by special glands but may appear in the urine or feces from hepatic or other sources.

Interpretation of the significance of the odoriferous glands is complicated by the fact that they may or may not be present in both sexes, and that they may or may not be affected by gonadectomy and gonadal hormones. The anal glands of the rabbit are very similar in buck and doe, are reduced in both sexes by gonadectomy, and are restored, though somewhat differently, by both estrogens and androgens. The supracaudal gland of the guinea pig is developed only in the adult male, is reduced by castration, and is restored by androgen. The flank glands of the golden hamster differ superficially in male and female only in size. In rats and mice, preputial glands are present in both sexes and in both are affected by gonadectomy and gonadal hormones. The sternal gland of the opossum is much better developed in the male, is reduced by castration, and is restored by testosterone. The malodorous flank gland of the male goat is also reduced by castration. On the other hand, gonadectomy does not affect the lateral gland of the short-tailed shrew, which is well developed in males and non-oestrous females but is reduced at oestrus and reduced still more during pregnancy (*22*). Other examples could be given showing the difficulty of making generalizations in this field.

In spite of the wealth of anatomical information available, little is known

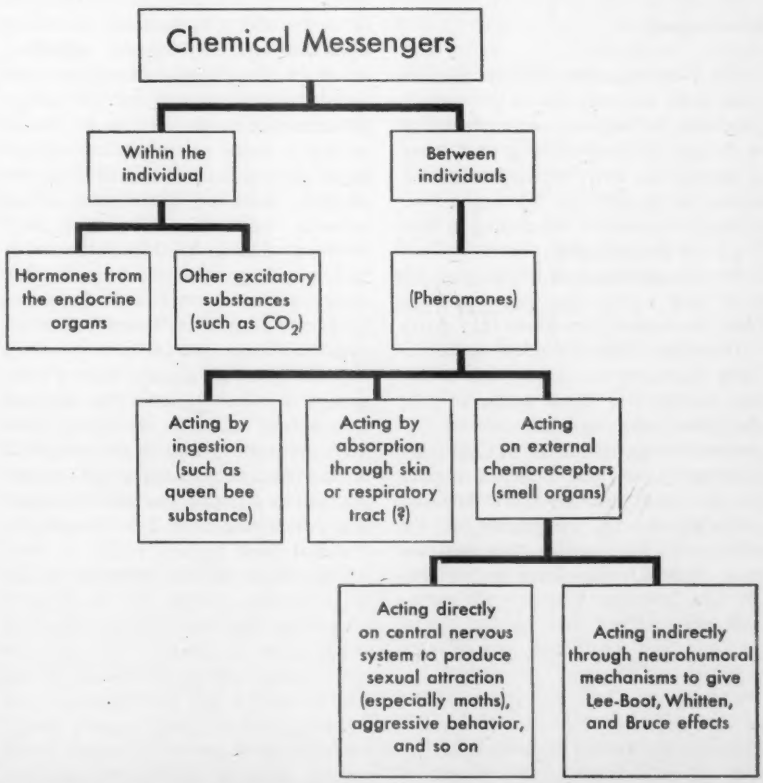

Chemical Messengers
Within the individual
Between individuals
Hormones from the endocrine organs
Other excitatory substances (such as CO_2)
(Pheromones)
Acting by ingestion (such as queen bee substance)
Acting by absorption through skin or respiratory tract (?)
Acting on external chemoreceptors (smell organs)
Acting directly on central nervous system to produce sexual attraction (especially moths), aggressive behavior, and so on
Acting indirectly through neurohumoral mechanisms to give Lee-Boot, Whitten, and Bruce effects

Fig. 5. Types of chemical messengers, especially types of those that integrate populations of individuals (pheromones).

about the nature or functions of the substances produced. Because of the interest of the perfume manufacturers, a great deal of chemical work has been done on the preputial glands of the musk deer and muskrat and on the perineal glands of the civet cat; muskone, civetone, dihydrocivetone, and a large number of other macrocyclic compounds have been isolated from these sources. Muskone has also been isolated from the preputial glands of the boar (*23*). Civetone is of especial interest because it has a chemical resemblance to Δ^{16}-androstenol, a steroid with a pleasant musky smell, related to the male hormones and present in pig testes and human urine. In other ways, also, the musk odor is far from specific, and a large number of artificial musks (many bearing, to the layman, little olfactory resemblance to natural musk) have been prepared; some of them (for example, musk xylene) are manufactured in enormous quantities for inclusion in cheap toilet preparations. From the point of view of the biologist, however, chemical work on animal odors has hardly begun.

Exocrinology

The odorous substances produced by male mice and effective under certain conditions in blocking ovoimplantation in females obviously belong to a group of substances, now coming into prominence, which offer an interesting contrast with hormones. According to Starling's classic definition, hormones are substances produced in one part of the body and carried by the circulating blood to another part where they evoke a response. This definition could include excitatory substances such as carbon dioxide, but in the course of time the term *hormones* has become restricted to the products of internally secreting glands, the endocrine organs. In any case, hormones are involved essentially in the integration of the individual. But Starling also used the term *chemical messengers* in this connection, and this term can now be given a much wider connotation, to include not only internal secretions involved in the integration of the individual but external secretions involved in the integration of populations of individuals (Fig. 5).

A notable example of this group of substances has recently been the subject of outstanding work by Butler, Callow, and Johnston (*24*)—that is, the queen substance of honey bees, 9-oxodec-2-enoic acid (*25*)—which is secreted by the mandibular glands of the queen bee and is ingested by the worker bees (undeveloped females), who are thereby retained in sexless subjection. If the supply of this substance is cut off by the death of the queen, the ovaries of some of the workers may develop, but the most obvious response is that the workers start to build queen cells in an attempt to requeen the hive.

The effect of the first-hatched mosquito larvae on the remaining unhatched eggs of the batch (*26*) may also be due to an externally secreted chemical messenger. Other interesting examples of these external chemical messengers, for which the name "pheromones" (*27*) has recently been suggested (*28*), are the sexual attractants of moths, which, at relatively enormous distances and in fantastic dilutions, stimulate the chemoreceptors of the antennae of the opposite sex. The sexual attractants of moths seem to be strictly analogous to the odorous substances of mammals which serve to mark sex and oestrous condition and evoke sexual behavior. Such effects, however, must be clearly distinguished from those that lead to pregnancy block in mice. Sex attraction and sexual and aggressive behavior induced by odors is an instantaneous, or at least very rapid, response, evoked directly through the central nervous system and needing only a brief stimulus. In strong contrast, pregnancy block in mice depends on a neurohumoral chain of events, initiated by a continuous olfactory stimulus which must last 2 to 3 days for maximal effect.

The effects of the presence of the male on the oestrous cycle in mice (*8*) and possibly in sheep (*29*) and goats (*30*) and on implantation in mice (*11*) appear to be the first effects of their kind to be described in mammals. The extension of this line of work to other species, perhaps even to man, and the identification and location of the substances involved are likely to be of absorbing interest. Endocrinology has flowered magnificently in the last 40 years; exocrinology is now about to blossom (*31*).

References and Notes

1. B. G. Bang, *Nature* **188**, 547 (1960).
2. R. B. Kelley, *Commonwealth of Australia Scientific and Industrial Research Organization Bull. No. 112* (1937).
3. S. Van der Lee and L. M. Boot, *Acta Physiol. et Pharmacol. Neerl.* **4**, 430 (1955).
4. ———, *ibid.* **5**, 213 (1956).
5. O. Mühlbock, *J. Endocrinol.* **17**, vii (1958).
6. A. D. Dewar, *ibid.* **18**, 186 (1959).
7. W. K. Whitten, *ibid.* **18**, 102 (1959).
8. ———, *ibid.* **13**, 399 (1956).
9. ———, *Nature* **180**, 1436 (1957).
10. ———, *J. Endocrinol.* **17**, 307 (1958).
11. H. M. Bruce, *Nature* **184**, 105 (1959).
12. ———, *J. Reproduct. Fertility* **1**, 96 (1960).
13. ———, *ibid.* **2**, 138 (1961).
14. ———, *ibid.* **1**, 311 (1960).
15. ——— and A. S. Parkes, *ibid.*, in press.
16. H. M. Bruce and D. V. M. Parrott, *Science* **131**, 1526 (1960).
17. H. M. Bruce and A. S. Parkes, *J. Endocrinol.* **20**, xxix (1960).
18. ———, *ibid.* **22**, vi (1961).
19. C. Champy, *Arch. intern. pharmacodynamie* **38**, 577 (1930).
20. R. Ortman, *Z. Saugetierk.* **21**, 138 (1956).
21. J. Schaeffer, *Die Hautdrusenorgane der Saugetiere* (Urban and Schwarzenberg, Berlin, 1940).
22. O. P. Pearson, *Anat. Record* **94**, 615 (1946).
23. R. H. Butt, B. C. Simpson, J. C. Christian, C. E. Barnhart, *J. Animal Sci.* **18**, 155 (1960).
24. C. G. Butler, R. K. Callow, N. C. Johnston, *Nature* **184**, 1871 (1959).
25. R. K. Callow and N. C. Johnston, *Bee World* **41**, 152 (1960).
26. J. D. Gillett, *Nature* **184**, 1621 (1959).
27. According to Karlson and Butenandt, the word means "carrying excitation."
28. P. Karlson and M. Lüscher, *Naturwissenschaften* **46**, 63 (1959); P. Karlson and A. Butenandt, *Ann. Rev. Entomol.* **4**, 39 (1959).
29. P. G. Schinckel, *Australian Vet. J.* **30**, 189 (1954); *Australian J. Agr. Research* **5**, 465 (1954).
30. M. Shelton, *J. Animal Sci.* **19**, 368 (1960).

31. We thank Dr. Dorothy Price for calling our attention to the supracaudal glands of the guinea pig, and Messrs. Ernie, Ferguson, and Kingston of Boake A. Roberts and Co. Ltd., for their comments, as expert perfumers, on the mouse odors characteristic of our various strains. We are also indebted to Dr. Delphine Parrott for the removal of the preputial glands and for the anosmic male mice, and to Miss M. V. Mussett for the tests of statistical significance. We acknowledge, with thanks, the generous supply of strain CBA mice made available by Dr. Mary Lyon of the Medical Research Council (Radiobiological Research Unit), Harwell.

Science and the News

The Joint Committee and the Atomic Energy Commission: A Case of Shared Management

A Washington lawyer, formerly on the staff of the Atomic Energy Commission, and a New York University political scientist have produced a 300-page report documenting the view that the Joint Congressional Committee on Atomic Energy has assumed a greater degree of influence over the policies of the AEC than congressional committees are normally able to assert over executive agencies—to the point, the authors feel, where the traditional division between the executive and legislative branches has broken down. The view, in the past at least, has been a widely held one, particularly within the AEC and the White House, some of the AEC staff feeling they are burdened more than other agencies with constant supervision from Congress, the White House feeling annoyed at the competition from the Joint Committee over who is to hold the dominant voice in influencing the Commission.

There are several sources of the Joint Committee's special powers: the fact that the committee is a joint committee, able to speak for both houses of Congress; the technical and often secret nature of the subject of the committee's jurisdiction, which makes it difficult for Congressmen not on the committee to challenge its views; and the specific provision in the legislation organizing both the AEC and the Joint Committee which requires the AEC to keep the committee "fully and currently" informed on what it is doing. This provision has been interpreted to mean that the Joint Committee should not only know about decisions that have been made, but about preliminary discussions and negotiations that will lead to a decision, and this ability to constantly look over the Commission's shoulder carries with it the opportunity to apply constant pressure on the Commission to move in a direction the Joint Committee deems proper. The result has been that the Joint Committee has both more power than many congressional committees, and, through the "fully and currently informed" provision, a special avenue through which to make its power felt.

"In considerable degree," a committee member wrote as long ago as 1952, "both Congress and the Commission jointly run the atomic program. Basic AEC policy decisions tend to be made with the advice and consent of the congressional committee. In the case of two vital policy matters . . . the drive and urging from the committee played so powerful a role that in a very real sense it can be said that the committee made the decision with the advice and consent of the Executive Branch. . . .

"At first glance this [fully and currently informed provision] might seem a frail foundation for Committee authority—merely the right to know with no legal jurisdiction to direct or supervise. Yet, in this atomic energy business, this simple right to know the highly secret facts in and of itself confers immense powers of moral suasion. Here, in a most literal sense, knowledge is power." To this could be added that, in any business, the right to constantly look over someone's shoulder, combined with the power to make life difficult for him if he fails to cooperate, puts one in an excellent position to direct what is being overseen.

The view of the committee is that Congress reserved for the committee special powers to supervise the development of atomic energy as a counterweight to the broad powers granted the Commission to develop policy in an area that was too new and rapidly developing for Congress to write much specific legislation. In the view of both the committee and the authors of the report, the principal effect of the committee's exercise of power has been to push the development of atomic energy faster than if policy direction had been left entirely to the executive branch. In both the committee's and the authors' views the exercise of power grew steadily during the years of the Eisenhower Administration, a situation that, particularly in the view of the committee, reflects the committee's efforts to fill the gap left by the White House's failure (in the committee's view) to press for sufficiently aggressive development of atomic energy.

At the time of the change in Administration a man in a position to speak for the committee acknowledged that the committee had probably asserted more authority over the Commission than had been contemplated when the two bodies were organized but said that he expected the power to recede because more aggressive leadership for the atomic energy program could be expected on the executive branch's own initiative. Something like this has happened. It is difficult for men to voluntarily give up power they have become accustomed to wielding, and the Joint Committee has not done so, but with both the committee and the White House in the hands of the same party the conflict between the two sides tugging for direction of the AEC has tended to be muted. The committee's special powers remain, as the committee members, and Congressmen generally, feel they should remain. But, at the moment anyway, they are no longer an obvious source of friction between the executive branch and the Joint Committee.—H.M.

Civil Defense: For Strategic Reasons, the Administration Has Limited Goals

The Administration's emphasis on civil defense, accompanied by the summer-long international crisis, has markedly diminished the public's long-standing indifference to the possibility of nuclear attack. Widespread concern is now evident throughout the country. A prospect that is now occurring to some Administration officials is that public concern, once so notably lacking, may outrun the carefully measured and relatively modest new civil defense program now getting under way.

It would be incorrect to say that public apathy has been replaced by excessive interest, but there definitely is an atmosphere of excitement—notably lacking in other countries—in the sudden evidence of popular concern with civil defense.

Civil Defense officials attribute much of it to the Berlin crisis, and some, with an instinct for finding silver linings, have privately gone so far as to express the hope that the crisis will continue long enough to convince the remaining doubters of the need to make preparations.

The difficulty is that the Administration has no desire or intention to go all the way in civil defense. The reason is not merely financial. In weighing relative values, the Administration came to the conclusion that it was worth an eventual expenditure of perhaps $20 billion to put men on the moon in this decade, vastly more than it plans to spend for civil defense. In considering the resources to be allotted to protecting the civilian population, it rejected the multi-billion-dollar proposals for deep blast shelters and settled on a program that for the present totals only some $300 million in federal expenditures. Private spending of at least $100 per family for civil defense preparations has also been recommended, but assuming even a large-scale response, it is clear that the Administration's program is a restrained one. Its choice was deeply influenced by students of strategy, including Herman Kahn, who have warned of the intentions that the Soviets might attribute to us if we embarked on a massive program of civilian protection.

Accordingly, the program offered by the President in his 25 July address to the nation is relatively modest in its goals, and aims principally at locating, marking, and stocking existing structures that would offer substantial protection against fallout: that is, the program is intended not to protect against the initial blast and fire effects but to protect the population that survives these effects. The amount of money involved is approximately 5 times what has been spent in each of the past 10 years, but there are no funds for—and apparently no serious thoughts of—large-scale and extremely costly deep shelters.

The Administration program reflects an awareness of many of the problems that have been pointed out in scholarly analyses of the strategic implications of civil defense. For example, a program built around fallout shelters, as opposed to blast shelters, cannot contribute to a mood of national truculence based on the assumption that the civilian population is extensively protected against a counterattack. And, while offering some protection, such a program would not loom so large in everyday life as to afflict the national psychology with a preoccupation about the imminence of sudden catastrophe.

The public concern in this country can be gauged to some extent by the inquiries about shelter construction which have been received by civil defense organizations. At the Office of Emergency Planning, which is the newly established presidential body overseeing civil defense efforts, it is reported that mail inquiries have risen from an average of 4500 a week in July to 6500 a day through August and September. Smaller, but still substantial increases have been reported at state civil defense offices.

Newspaper accounts tell of a sharp increase in home shelter construction. In many cases, it is reported, the purchasers conceal the purpose of the construction, sometimes to avoid curiosity seekers, but in other cases to make certain that if the need for shelter arises, the neighbors will not attempt to crowd in. There have been accounts of discussions on the morality of barring one's neighbor from shelter. And a financial newsletter recently told of investment opportunities in civil defense supplies and equipment.

Thus, while the program is relatively modest, the public response is not, and this has been particularly noted by European visitors to this country. The answer may be that other nations are turning their backs on a catastrophic possibility, while we are realistic enough to attempt to do something about it. Regardless of the wisdom inherent in the conflicting reactions, the fact is that, in the United States alone, there is widespread public concern about protection against nuclear attack. Students dispute whether the Soviet Union is making similar preparations for its population. Repeatedly, it says it is not, and this conforms to the observations of the New York *Times* correspondent in Moscow. However, it has also been reported that without being conspicuous or noisy about it, the Soviet government has taken extensive steps to protect its civilian population.

Whatever the Russians are doing, the Administration has charted a program that seeks to balance difficult and often conflicting requirements. While seeking protection for the American public, it cannot be oblivious of the effects that would be produced both on the American character and Soviet suspicions if a massive program for constructing blast-proof shelters were undertaken.

In the course of ending their apathy toward civil defense, great numbers of citizens have come to contemplate what steps they should personally take to survive an unfathomable horror. It is the Administration's desire that the emotional wrench involved will not nurture thoughts of dangerous solutions to the East-West conflict.—D.S.G.

Reapportionment: The Supreme Court Takes Up an Issue with Far-Reaching Implications

The Supreme Court this week heard an appeal from a group of urban Tennessee voters who claim that, in violation of the state constitution, their areas are underrepresented in the state legislature.

The case is of far-reaching significance for the political alignments in numerous state legislatures and, ultimately, in the House of Representatives. A ruling for the plaintiffs could redress the imbalance between urban and rural representation on the state level. Since the state legislatures decide the boundaries—and therefore the size of the electorate—in congressional districts, such a ruling also could eventually give urban areas heavier representation in the House.

The Tennessee group contends that while the state constitution calls for reapportionment of the legislature every 10 years, the legislature last acted on this in 1901. As a result, say the plaintiffs, one rural vote in Tennessee can be worth as many as 19 urban votes in selecting members of the lower house. In many states afflicted by this problem, city voters find that the bulk of state revenues originate in urban areas, but are controlled by rural-dominated legislators who have no sympathy for urban problems of schooling, traffic, air and water pollution, and redevelopment.

The case that came before the Supreme Court is restricted to a state issue, but the implications are clear for congressional reapportionment, which often reflects similar urban-rural disparities of population and representation. Reapportionment of congressional districts could sharply affect the political makeup of the House, which in the last session repeatedly blocked or reduced Administration programs, such as the comprehensive education bill, that easily passed the Senate.

In accounting for the differing political temperaments of the two houses, it has been suggested that senators, with their majorities often based on urban areas, are more inclined to reflect the liberal leanings of the cities. Thus many Republican senators have far more liberal voting records than many rural Democratic representatives.

An additional possibility that could follow a ruling in behalf of reapportionment could be new revenue programs that would give big cities a larger share of state revenues and lessen the pressure that makes them seek federal aid.

Regardless of how the Supreme Court rules, however, the effects of its decision will be slow to arrive, and reapportionment will probably be fought long and hard in states where the disproportionate representation is greatest.

Conference on Quackery

The American Medical Association, which has had a difficult time recently doing anything without being attacked for putting its members' economic interests ahead of the public interest, devoted 2 days last week to sponsoring a national conference on quackery, an enterprise which brought only favorable publicity. Everyone is against quackery, which, the conferees agreed, is flourishing.

A figure of $1 billion a year was suggested by the AMA as the annual cost of quackery, broadly defined to include all unnecessary or worthless medication. This includes most of the $350 million spent on vitamin pills, which few Americans need but many buy in response to advertising that suggests it costs only a few cents a day to be on the safe side; almost all the $260 million spent on laxatives and patent medicines; and a good deal of the $68 million spent on aspirin. Another $250 million a year is spent on cures for arthritis and rheumatism, for which there is no cure.

The grosser class of quacks, peddling magnets, packets of uranium ore, condensed sea water, and such, guaranteed to cure any and all diseases, are, in terms of total business, comparatively small stuff, with the exception of cancer-cure peddlers. Fifty million dollars a year are spent for cancer cures, a good deal of it, apparently, by people who do not have cancer, but think they do, and who thereupon are likely to write thankful testimonials to the quack they believe saved their lives.

The business of quackery is thus divided into the large-scale, but borderline, quackery promoted by nationally known firms selling products of some value, such as vitamin pills and laxatives, and the full-blown quack, offering a cure for anything the customer may think he has. The large firms cannot get too far out of line, since the Federal Trade Commission and the Food and Drug Administration have only to turn on a TV set to find out what they are telling their customers. A continuing game is played between these firms and the government regulatory agencies to see how far they can go in exaggerating the benefits or need for their products without providing the government with clear enough evidence to get a court to support a finding of misleading or fraudulent advertising. (An especially charming gambit was used several years ago by a laxative manufacturer who suggested that "if you have Asian flu, and need a laxative, take ———." Nothing came of this, because the Asian flu epidemic, and hence the advertisement, was gone before the government could act, but presumably a claim that "if you have cancer, and need a laxative, take ———," would stir the Federal Trade Commission to prompt action.)

What borderline quackery does is to encourage people to waste their money, usually in small enough quantities that no single customer is noticeably harmed. The authentic quack, on the other hand, may be doing a good deal of harm by depriving his customers of proper treatment and, since he operates on a less-efficient scale, often completing each sale with a personal call, he must make each customer pay well for his services. But exactly because the operation is normally carried on on a small scale, not using the national advertising media, it is difficult for the federal agencies to control this kind of quackery: it is expensive to track down each practitioner and to get a court conviction. The penalties for getting convicted are not severe, usually a small fine for a first offense. The result is that new quacks spring up as fast as the old ones are put out of business. The constant threat of harrassment by federal agencies, though, presumably limits the temptation to go into the business, and consequently keeps down the prevailing level of quackery lower than it would otherwise be.

Two methods of attack on this grosser quackery were suggested at the conference: an AMA official suggested that the state medical associations exert themselves to attempt to see that laws with reasonably strict penalties for the unlicensed practice of medicine were passed and enforced. This has already been done in California and several other states, although the stricter provisions of the laws are often limited to cancer quacks. Another line of attack was suggested by an FDA official who reported that the Administration's version of the Kefauver drug bill would ask for powers to require proof of efficacy for all drugs before they could be put on the market. Kefauver's version of the bill applies only to prescription drugs. Under the FDA version the bill would apply to nonprescription drugs and would greatly simplify the FDA's problem in dealing with quackery. Under current laws FDA must prove that the questionable medicine will not cure what it is presented as curing. If the bill passed, the burden of proof would shift to the medicine man, for it would be illegal to sell a drug until after satisfactory proof that it will be effective has been presented to the government agency.

For dealing with the borderline quackery, Paul Rand Dixon, formerly Kefauver's chief counsel and now chairman of the Federal Trade Commission, said the agency would begin experimenting with a little-used power to ask a court for an injunction to stop misleading advertising in food and drug cases pending the final determination of the case. Indeed Dixon said he would ask Congress for the power to issue the injunction directly, without going to a court. He is unlikely to get this power, but if the FTC can make wide use of the court-issued injunction it will greatly increase the efficiency of the organization. Under present law there is an incentive on the part of an advertiser to fight a case out as long as possible even if he has little hope of winning, since he can, without penalty, continue the misleading advertising as long as the matter is still before the courts. Lacking this incentive, offending advertisers would presumably tend to settle their cases more willingly, and the FTC could use its limited resources to fight more cases. The prize for such delaying action goes to the manufacturers of Carter's Pills, until recently Carter's Little Liver Pills. On 28 May 1943 the FTC issued a complaint charging that

the pills, contrary to the name and advertising, were merely a mild laxative having nothing to do with the liver. The commission finally won its point on 15 December 1959, something over 16 years later, during all of which time the company aggressively promoted the pill on the basis of the wondrous, although vague, benefits that it would produce by stimulating the flow of liver bile.

IAEA: Soviets Threaten Withdrawal

The Soviet representative to the International Atomic Energy Agency said last week that he probably would advise his government to withdraw its membership. The threat, from Vasily Yemelyanov, was made at IAEA's general conference in Vienna, following rejection of a Soviet effort to have an Asian or African neutralist succeed to the directorship of the agency.

The Soviet position, which was backed by the Communist nations and 11 African and Asian nations, was rejected by the conference, which elected a Swede, Arne Sigvard Eklund. Eklund's election, Yemelyanov charged, reflected an attempt by the U.S. to dominate the agency for political and military purposes.

Although the future of Soviet relations with the IAEA remains unclear, it is apparent that the Soviets have no intention at this point of permitting the agency to develop into the East-West meeting ground for nuclear science that was envisaged at its founding in 1957.

The hardening of the Soviet attitude toward IAEA followed closely upon President Kennedy's suggestion that the agency undertake certain nuclear inspection functions in an East-West disarmament agreement. Although IAEA is capable of functioning without Soviet participation, its role as an East-West bridge for peaceful nuclear efforts is crippled for the foreseeable future.

Student-Teacher Relationship

The American Civil Liberties Union warned this week that the student-teacher relationship may be threatened by prospective employers looking into the background of students. The ACLU said that academic performance is of legitimate interest, but that the relationship is undermined when teachers disclose information on students' social beliefs, loyalty, and religious and moral attitudes.

Announcements

Applications are being accepted for participation in the American Institute of Biological Sciences' 1961–62 **visiting biologist program**, supported by the National Science Foundation and the Atomic Energy Commission. The program allows U.S. biologists to visit a college, small university, or high school for a 3-day period, and foreign biologists to visit at least three colleges, laboratories, or other scientific centers over a 1-month period, for participation in seminars, lectures, consultation with faculty, and scientific or career discussions with students. (Martha J. Acker, AIBS, 2000 P St., NW, Washington 6, D.C.)

A **moisture detector meter** has been developed by the U.S. Army for use at missile installations and other areas where undetected moisture might cause malfunction of instruments and equipment. The device, called an electric hygrometer, consists of platinum wires enclosed in a small tube which has been coated with a thin film of phosphorous pentoxide, a material with a strong affinity for moisture. The 35-pound analyzer absorbs and simultaneously electrolyzes all moisture from a sample gas stream. The instrument is capable of detecting moisture in high-pressure air (up to 6000 lb/in.^{2}) and measuring moisture content down to a free-air dewpoint—100°F.

According to a Rockefeller Foundation study group, **voluntary health and welfare agencies** often compete wastefully among themselves. The agencies, the report states, do much good but often fail to tell the truth about their programs and financing. The group recommends that a national commission be established to coordinate planning and development of a uniform system of accounting and financial reporting among the agencies. (Rockefeller Foundation, New York)

Two additional **standard samples of radionuclides**—iron-55 and promethium-147—are being issued by the National Bureau of Standards. The two standards are part of a group of 51 now available through the bureau's program to establish new and improved radioactivity standards. (Radioactivity Standard Samples, National Bureau of Standards, Washington 25, D.C.)

Soviet research laboratories for study on the use of **isotopes and radiation in agricultural science** increased tenfold between 1952 and 1957, according to a U.S.S.R. publication. The 119-page volume, translated by the U.S. Department of Commerce, reviews Russia's basic achievements in agricultural science during the past 40 years and discusses plant breeding; plant pests and diseases; veterinary science; fodder production; reclamation; and rural electrification. (Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C. Order No. 60-51199. Price: $1.25)

Chemists and chemical engineers able to do **abstracting of research publications on chemistry** are needed, especially those with a knowledge of one or more foreign languages. There is a special need for abstractors of German patents and Russian research publications. The individual's field of chemistry, language or languages, and available time are considered in the assignment of papers for abstracting. (Charles L. Bermier, *Chemical Abstracts*, Ohio State University, Columbus 10)

A new booklet, "How to Donate Your Body for Medical Science," reports the need for **bodies for research;** lists states which have laws assuring a donor that his bequest will not be nullified by the next-of-kin; describes a bequest procedure in which a standard form provided by most medical schools is used; and discusses common funeral and burial procedures. (National Society for Medical Research, 920 S. Michigan Ave., Chicago 5)

Descriptions of 70 new **viral and rickettsial agents** currently available for distribution are contained in a recently published supplement to the 1959 catalog of the American Type Culture Collection. Copies of the 1959 catalog, containing descriptions of 153 strains previously available from the ATCC, may also be obtained on request. (American Type Culture Collection, Viral and Rickettsial Registry & Distribution Center, 2112 M St., NW, Washington 7, D.C.)

Three new **standard samples of titanium**, containing three different levels of hydrogen, are now available from the National Bureau of Standards. The new materials are part of a series

initiated in 1959 to provide standards suitable for calibrating chemical analytical equipment employed to measure the gas content in various alloys. (Standard Sample Clerk, National Bureau of Standards, Washington 25, D.C. Price: $10 per sample)

Meeting Notes

A specialists' conference on **culture collections** will be held on 27 and 28 August 1962 in Ottawa, Canada. Discussion topics will include fundamental and technical aspects of the preservation of microorganisms and other cell cultures, with special emphasis on maintenance of morphological, physiological, and genetic characteristics. Attendance will be by invitation only. Deadline for receipt of applications: *1 December*. (S. M. Martin, Division of Applied Biology, National Research Council, Ottawa)

A symposium on **redundancy techniques for computing systems** will be held on 6 and 7 February 1962 in Washington, D.C. The program will consist of papers invited from organizations engaged in appropriate research and development activities. Attendance is open to all interested technical personnel. (Josephine Leno, Code 430A, U.S. Department of the Navy, Office of Naval Research, Washington 25, D.C.)

The first international conference on **vacuum ultraviolet radiation physics** will be held 16–19 April 1962 at the University of Southern California. Only invited papers will be presented, primarily for general survey purposes concerning research accomplished, in progress, or in the active planning stage. The conference, sponsored by the National Science Foundation, is open to all members the scientific community. (G. L. Weissler, University of Southern California, Los Angeles 7)

The first national scientific congress of the **Czechoslovak Society of Arts and Sciences in America** will be held from 20 to 22 April 1962 in Washington, D.C. The program, covering the contributions of Czechoslovak art and science to world culture, will include a section devoted to Czechs and Slovaks abroad. Deadline for submission of 200-word abstracts: *1 January 1962*. (M. Rechcigl, Jr., 1703 Mark Lane, Rockville, Md.)

Scientists in the News

Jerome Lederer, director of the Flight Safety Foundation and the Cornell-Guggenheim Aviation Safety Center in New York, will receive the 1961 Daniel Guggenheim medal for his work in aeronautics. The award is sponsored jointly by the American Society of Mechanical Engineers, the Society of Automotive Engineers, and the Institute of the Aerospace Sciences.

F. R. Bruce, nuclear chemist, has been appointed to the newly created position of assistant deputy director of Oak Ridge National Laboratory. He will continue as director of ORNL's radiation safety and control program.

Alfred Yankauer has been appointed adviser in maternal and child health for the Pan American Sanitary Bureau, a regional office of the World Health Organization. He was formerly director of the New York State Department of Health's Bureau of Maternal and Child Health Services.

Recent awards to staff members of California Institute of Technology:

Rudolph Minkowski, visiting professor of astronomy, has received the 1961 Bruce gold medal of the Astronomical Society of the Pacific.

Ernest H. Swift, chairman of the Division of Chemistry and Chemical Engineering, has received the 1961 honor scroll of the American Institute of Chemists' western chapter.

Washington Buno, of the University of Montevideo (Uruguay) is visiting professor of anatomy during the current academic year at the University of Illinois College of Medicine.

Seymour S. Kety, professor of psychiatry at Johns Hopkins, has received the 1961 Alvarenga prize of the College of Physicians of Philadelphia, for his work on "cerebral blood flow and the effect of drugs on the central nervous system."

Wallace E. Stegner, author and professor from Los Altos, California, has been appointed a special conservation research assistant to Secretary of the Interior Stewart L. Udall. **Paul Horgan**, of New Mexico, and **Leonard Hall**, Missouri conservation columnist, will also conduct short-term regional research in the field.

J. Clark Salyer, II, chief of the U.S. Fish and Wildlife Service's Branch of Wildlife Refuges for 27 years, has been assigned to the agency's Division of Wildlife. He is succeeded by **Eugene E. Crawford**, assistant chief of the branch.

Clarence E. Larson, associate manager of research for Union Carbide Corporation, has been appointed a vice president of the Union Carbide Nuclear Company and general manager of its Oak Ridge operations, conducted for the U.S. Atomic Energy Commission.

Joseph E. Barber, psychologist and former member of the White House Conference for the Study of the Gifted, has been appointed director of research and public relations for Careers, Largo, Fla.

Cecil J. Watson, professor and head of the department of medicine at the University of Minnesota, has received the Distinguished Service award of the Minnesota Medical Foundation. The award provides annual payments of $5000 until retirement.

Felix Haas, chairman of the department of mathematics at Wayne State University, will become director of Purdue University's division of mathematical sciences, effective in February 1962.

Roy D. Bronson, agricultural engineer formerly with the United Fruit Company's Division of Tropical Research, has been named branch chief in the Tennessee Valley Authority's Division of Agricultural Relations.

Walter R. Hicks, vice president in charge of special projects at Reeves Soundcraft Corp., New York, will receive the Samuel L. Warner memorial award of the Society of Motion Picture and Television Engineers for his work in sound recording.

Raymond Forer, former director of the behavioral sciences program at the Kentucky State Department of Health, has been appointed professor and head of the newly created department of sociology and anthropology at the University of Maine.

Edward L. Powers, leader of the microbiology group in Argonne National Laboratory's Biological and Medical Research Division, is the first noncitizen

of the United Kingdom to be named a Douglas Lea memorial lecturer. The lectures, given biennially, are sponsored by the British Hospital Physicists' Association.

Yudell L. Luke, head of the mathematical analysis section at Midwest Research Institute, has been named senior adviser for mathematics at the institute.

V. Lawrence Parsegian, former professor of nuclear engineering at Rensselaer Polytechnic Institute and dean of the institute's School of Engineering, has been named the first Rensselaer Professor.

Cadet Hand, professor of zoology at the University of California (Berkeley), has been appointed acting director of the university's new Marine Biology Field Station currently under development.

D. Jerome Fisher, professor of mineralogy at the University of Chicago, reached emeritus status on 1 October. He plans to continue with his research work in the department.

James A. R. Samson, research physicist who recently established a vacuum ultraviolet laboratory at Harvard, has joined the staff of the Geophysics Corporation of America.

Eleanor J. Bader, physical therapist and a former executive director of the Delaware Curative Workshop, Wilmington, has been appointed program consultant to the National Society for Crippled Children and Adults.

E. G. D. Murray, visiting professor in medical research at the University of Western Ontario, has been named the 12th Augustus B. Wadsworth lecturer of the State Association of Public Health Laboratories, New York.

Walter O. Walker has retired as dean of research and industry and professor of chemistry at the University of Miami. He will remain at the university as director of the industrial chemical research laboratory.

Gilbert F. Hamilton, of Aberdeen University, Aberdeen, Scotland, will serve as visiting professor of anatomy at Marquette Medical School, Milwaukee, for the 1961–62 academic year.

Karl F. Meyer, professor emeritus of experimental pathology at the University of California Medical Center (San Francisco) and director emeritus of the university's George Williams Hooper Foundation for Medical Research, has received the 1961 Griffin award of the Animal Care Panel.

John W. Hamblen, former director of the computing center at the University of Kentucky, has been named director of Southern Illinois University's data processing and computing center.

Captain **John R. Seal**, former commanding officer of the Naval Medical Research Unit in Cairo, Egypt, has assumed command of the Naval Medical Research Institute, Naval Medical Center, Bethesda, Md.

J. Robert Snyder, former associate professor of chemical engineering at Villanova University, has been named associate professor of chemical engineering at Pennsylvania State University.

Chauncey G. Bly, former consultant in radioisotopes and pathology to the National Cancer Institute, has been appointed president of Thiel College, Greenville, Pa.

William A. Ogletree, physicist and former vice president and general manager of Computer Systems, Inc., has been appointed general manager of the Sarasota products division of Electro-Mechanical Research, Inc.

Charles E. Osgood, director of the University of Illinois' Institute of Communications Research, has been elected president of the American Psychological Association, effective in the fall of 1962.

Brooks T. Morris, director of the propulsion division of Marquardt Corporation, has been appointed to the newly established position of special assistant for reliability assurance at the California Institute of Technology Jet Propulsion Laboratory.

Daniel Fromm, professor in the newly formed department of food science and processing at North Carolina State College of Agriculture and Engineering, has received the Institute of American Poultry Industries' $1000 award for his work in poultry and egg products technology.

James Watt, director of the National Heart Institute, has been appointed director of the Public Health Service's Division of International Health.

Howard L. Poss, former technical staff member of Radio Corporation of America Laboratories, has been appointed associate professor of physics at Temple University.

Cyrus O. Guss has been named professor of chemistry and chairman of the department at the University of Nevada. During the past year he has been serving as a visiting lecturer at the University of Illinois while on sabbatical leave from Colorado State University.

Charles H. Rammelkamp, Jr., professor of medicine at Western Reserve University, will receive the first research achievement award of the American Heart Association.

David C. Goldberg, of Westinghouse Electric Corporation's astronuclear laboratory, and **Roger A. McIntyre**, of the company's air arm division, have been appointed director and associate director, respectively, of the company's newly formed space materials department.

James S. Swinehart, assistant professor of chemistry at Wagner College, Staten Island, N.Y., has been appointed associate professor of chemistry at American University, Washington, D.C.

Jerome Rothstein, senior scientific executive for Edgerton, Germeshausen and Grier, Inc., in Boston, has been named vice president and chief scientist for Maser Optics, Inc., Cambridge, Mass., a recently formed company which specializes in lasers and coherent optics.

Recent Deaths

Homer T. Gittings, Jr., 40; laboratory group leader at the University of California's Los Alamos Scientific Laboratory; 7 Sept.

Lawrence Reynolds, 72; roentgenologist and past president of the American College of Radiology; 17 Aug.

Percy Viosca, Jr., 69; fisheries biologist with the Louisiana State Department of Conservation; 27 Aug.

Errratum. The last sentence in the next-to-last paragraph on page 873 of L. Pettit's letter "Soviet commitment to Lysenkoism" [*Science* 134, 872 (22 Sept. 1961)] mentions ". . . the familiar 1:21:1 ratio of red, pink, and white F_2 flowers. . . ." The ratio should have been 1:2:1.

Rock 'n' Roll

Is there an adolescent subculture in our society, with its own elite group, independent values, and aspirations?

William Petersen

The very process of education induces most who write about it, including the authors of virtually all of the recent spate of books on American public schools, to see students as merely passive, molded by their teachers, their curricula, their school administrators. Here is a book—entitled **The Adolescent Society**—that tells us something of the independent values and aspirations of high school students. Coleman has looked under the rock on which the school system is built and has opened up to adult view fauna of which even the parents among us generally know little.

Ten schools in northern Illinois participated in the study, ranging in enrollment from 150 to almost 2000, and situated in communities that typified a farm village, a small town with light or heavy industry, a working-class or a middle-class suburb, and the center of a large city. Two questionnaires were administered to the entire student bodies, and supplementary information was gathered from school records, teachers and administrators, and parents.

Many of these facts are of considerable prima facie interest. About half of the respondents prefer rock-and-roll to any other kind of music. Two-thirds of the boys and more than three-quarters of the girls never smoke or drink even beer. The proportion of boys owning a car ranges from four-fifths in the farm community to almost one-fifth in Chicago, and everywhere car ownership is an important symbol of status and a great aid in dating. Many more would rather be a good athlete or a leader in extracurricular activities than a brilliant student; and this preference is fostered by the colleges, which compete for the football or basketball player but let the good student seek his own admission. "Because high schools allow adolescent societies to divert energies into athletics, social activities, and the like, they recruit into adult intellectual activities many people with a rather mediocre level of ability, and fail to attract many with high levels of ability." Bright students, just because they are bright, see that the greatest social rewards are paid for activities officially defined as peripheral to the school's main purpose, and some of the boys and girls respond accordingly.

Nonintellectual Clutter

A good high school administrator, in Coleman's view, uses extracurricular activities to make the school attractive to its students, while still maintaining the regular curriculum in its central place. The author returns to this dilemma in a number of contexts. In a discussion of the problems that have developed out of coeducation, for example, he points out that "the opposite sex in a school pulls interests toward the school, and then partly diverts it to non-scholastic matters." Similarly, athletics, clubs, high school bands, and all the rest of the rich variety of nonintellectual matters that clutter up secondary education are legitimate as bait; for the basic fare of science, history, and literature could not otherwise be made palatable. This is particularly so, he maintains, for schools in working-class neighborhoods, but it holds also for others, even where all the students are oriented toward college. As these examples suggest, Coleman tries to avoid joining sides in the great debate on public education. The antithesis between "academic emphasis" and "life adjustment," he writes, is "a false one, for it forgets that most of the teen-ager's energy is not directed toward either of these goals." In other contexts, however, he suggests that one important reason students find their studies dull is that educationists have eliminated scholastic competition, which has been largely supplanted by competition for social standing.

In maintaining a balance between curriculum and athletics, what shall be done with a student who is able to excel in one or the other? "Is it better for the social system to push an athlete toward studying and a scholar toward athletics, or to push them further in their present directions?" Even those who administer college scholarships seemingly prefer breadth to depth, and Coleman shows what price is paid for such a policy. By emphasizing what the author terms the "all-around boy," administrators can force athletes to raise their grades, but they also induce good students to lower theirs one or even two grade points below the average in schools that encourage adolescents to concentrate on their studies.

As these examples suggest, this interesting and important book, highly competent within its narrow range, deserves attention from not only educators and sociologists but also the literate lay public. Unfortunately, it is also marred by a number of flaws, and these are typical enough of the genre to warrant extended comment. Survey analysts have developed some highly specialized skills with which they can often, as in this case, add new insights to a well-worked field. These skills, however, cannot be an adequate substitute for everything that came before them. Even with a well-constructed questionnaire, careful coding, and provocative analysis of the opinion data, one cannot write a book without knowing how to write, or analyze an institution in a social vacuum.

The professional cant of survey analysts is at best inelegant, at worst incomprehensible. In this book one encounters "most no-answers were nonfinishers," "the average number of mentions of someone," "the within-girl variance in grades," and so on and on. Telegraphic non-English, endemic throughout the text, dominates in the tables and graphs, most of which cannot be understood apart from the accompanying commentary. One column is headed, for instance, "2+ Be like"; this means, those students named two or more times in response to the question, "Thinking of all the boys (girls) in this school, who [sic] would you most want to be like?" It is his insensitivity

The author, associate professor of sociology at the University of California, Berkeley, reviews here *The Adolescent Society: The Social Life of the Teenager and Its Impact on Education*, by James S. Coleman (Free Press, Glencoe, Ill., 1961. 384 pp. $6).

to language, one presumes, rather than his naivete, that induces the author to tell us that "adolescents as a whole are not delinquent," or that "athletics is an activity in which all boys start on a fairly equal footing, regardless of background," or to make a dozen similar statements that startle only because they are ineptly worded.

On Reality and Perception

A generation ago the American sociologist W. I. Thomas set forth a theorem for his professional associates: "If men define situations as real, they are real in their consequences." Today, when survey analysts have learned this lesson too well, one must again emphasize the obvious: No matter what persons perceive, or say they perceive, events and behavior are determined in part by what is, by social reality. That is to say, no analysis can be complete if its only foundation is responses to a questionnaire.

Consider, for example, the following passage: "All parents' questionnaires were coded by one person, who was otherwise unfamiliar with the communities, the schools, or the aims of the research. After finishing the parents' questionnaires for a given school, he made a page or two of notes on the community and school as seen through the parents' eyes and as reported by them in their comments. These descriptions, of course, are not accurate, but they give a flavor of the community and school as seen by parents." Granted that this flavor is useful, should there not also be a main dish of empirical facts about the communities? One could imagine that northern Illinois is some exotic land, with no census or other records, to be known only through the patently inaccurate characterizations by a few of the natives. Or at least this is the best description available from a well-known sociologist, working with grants from the U.S. Office of Education and the Ford Foundation.

If this judgment seems too harsh, consider the way that Coleman puts his study in historical perspective. He begins with a newspaper account of education among the Amish, a small rigidly fundamentalist sect, and uses them as a contemporary example of what Americans were like before industrialization. Journalists who know no history often contrast the prior stable agricultural society with the rapidly changing present one, but seldom in such preposterous terms. Several generations ago Illinois was still a frontier; two generations ago many of its inhabitants were European-born. Around 1900, the high school was essentially the preparatory school for the small minority that went on to college. Today the native-born students, mostly of native-born parents, attend high school almost as a matter of course. To call their social world less, or more, stable is a generalization that must be specified to acquire any meaning.

When survey data are analyzed in a social vacuum, this fact is usually not apparent on the surface, for the data are used to construct the framework within which they are studied. There is a fundamental difference between asking persons whom they will vote for as president of the United States and asking high school students who they think is in "the leading crowd": we know that there will be an election, but whether there *is* a leading crowd is one of the questions the researcher must ask—not beg. Sociologists have made a number of studies, for instance, of what they termed the "power elites" of various communities; more recently, it has been shown that different persons decide which books should go in the public library, whether a street should be paved, whether a rise in pay for firemen should go on the ballot, and so on through all the decisions that constitute municipal life. Whether students, who have very little formal power, throw up an elite in any sense is even more dubious; and in one isolated passage Coleman says as much:

"Who shall be called the elites in these schools? At the extremes there is no question: those never named are obviously not elites, and those named most often are obviously elites (in the sense indicated by the questions). But the problem is not so easily solved for those in the middle who received some, not a great many, choices. The answer seems to be that in such a situation of informal organization, people cannot be clearly divided into leaders and non-leaders, popular heroes and non-heroes. Instead, leadership resides in many people, in varying degrees."

If this is true, and I think it is, then much of the argument of the whole book is undermined. If the "leading group" or the "elite" is not really a model (a "be like," in Coleman's idiom) for more than an indeterminate, but probably small, proportion of the students, then a study that presumes to analyze "the adolescent society" by looking mainly at this model suffers from a fundamental inadequacy.

Is there an adolescent subculture? (With an indifference to technical language remarkable in any professional social scientist, Coleman uses adolescent "society" or adolescent "culture" more often than the more correct term.) One dimension of this question we have already touched on: do all adolescents form a unit? In the sense that they are all intermediate between childhood and maturity, obviously yes; with respect to their values and aspirations, just as obviously no. There are not only differences of sex (which Coleman if anything exaggerates) and of social class (which he analyzes with acuity), but differences among various schools or even the four classes within a single school, and particularly among "cliques"—that is, individuals and those they chose as their friends. That the young persons interested in intellectual matters make up only a minority of Coleman's sample does not distinguish it, I would say, from any human population whatever; and the reiterative suggestion that social disintegration is in process is—like Mark Twain's death notice—a bit premature.

Teen-agers' Viewpoint

The second dimension of the question of the adolescent subculture is how, and how much, it is distinguished from the general adult culture. Coleman insists that "the adolescent lives more and more in a society of his own"; "our adolescents today are cut off, probably more than ever before, from adult society." I would say that the comment of an anonymous teenager, cited in one footnote, is better social analysis: "As an adolescent, looking at our [adolescent] society from a distance, it seems to me to be merely an immature adult society. This immaturity is responsible for the 'world of difference' between the culture of the teen-ager and the adult. . . . The adolescent borrows for his society the 'glamorous and sophisticated' part of adult society. The goals and worthwhile activities of the adult world are scorned because they involve responsibilities, which the adolescent is not ready to accept."

Russian Challenge

The Role of Speech in the Regulation of Normal and Abnormal Behavior. A. R. Luria. J. Tizard, Ed. Pergamon, New York, 1961. 100 pp. $8.50.

This little lithographed book consists of the text and illustrations of three lectures given at University College, London, in 1957–58, by A. R. Luria, one of the best known and most distinguished Russian psychologists. The lectures were devoted to the empirical examination of the role of speech in the regulation of nonlanguage behavior. The nonlanguage behavior dealt with throughout the book was ordinarily a simple, voluntary motor response made in the presence of an auditory or visual signal as a result of verbal preinstruction (for example, "Press when the light comes on"; "Press every third time the bell rings"). This elementary situation was utilized to explore the extent to which subjects (children and persons with brain pathology) could use, first other persons; and then their own, verbalizations to bring their motor behavior into the desired relationship with events in the experimental situation. The ingenuity shown by the investigators in the analysis and development of extensive programs of research must command respect and admiration from psychological research workers everywhere. In many ways the work is reminiscent of the basic study of classical conditioning and its ramifications, made by Pavlov and his students. Results of scores of experiments are presented to illustrate and support current Russian conceptions of (i) the formation of higher mental processes, (ii) the emergence of speech as a regulatory mechanism, and (iii) the modifications of the role played by speech as a result of brain pathology.

For the reader with a command of Russian, the current references cited will prove valuable; for the reader without Russian, this book is virtually the only source for much of the material. Unfortunately, the details of many of the experiments are sparse and the results are illustrated rather than documented in the statistical fashion approved in current Western psychology. This should furnish no deterrent to the interested research worker, however. As C. A. Mace points out in his foreword, the book now makes replication of these studies possible, and it is to be hoped that many workers will rise to the challenge of the ideas expressed in the lectures and that they will systematically replicate and extend the experimental work reported.

The book should furnish excitement and stimulation for research workers in the psychology of language for some time to come.

JAMES J. JENKINS
Department of Psychology, University of Minnesota

Paleozoic Questions

Geologie von Bayern. Adolf Wurm. Borntraeger, Berlin, 1961. xvii + 554 pp. Illus. + maps. DM. 96

Adolf Wurm, professor emeritus at the University of Würzburg, has devoted most of his life to the geological investigation of Bayern, or Bavaria, the second largest state of prewar Germany (about three-fourths the size of New York State). Geologically Bavaria includes orogenic areas of Paleozoic as well as of alpine age and was therefore predestined for an early leading role in the solution of Paleozoic stratigraphic and tectonic questions.

The first edition of this book was published in 1925. Since then much work has been done, and many new detailed maps have come out. Wurm has done a very commendable piece of work in completely re-editing his original monograph. He consulted and listed over 1000 references, a large proportion of which appeared after publication of the first edition. The volume is dedicated to C. W. von Gümbel, the father of Bavarian geology.

Bavaria is the "type locality" or "lieu of origin" of various new rock names (for example, Gümbel's name, *keratophyre*), of tectonic periods (for example, Variscan orogeny), and of many important new fossils, mainly of Paleozoic age. It also played an early and a leading role in the solution of geologic problems in Germany and in Europe as a whole, although it never attained the fame of the Swiss Alps.

The arrangement of the text is logical and the book is well organized. The major sections are as follows: A brief introduction with a valuable review of the history of geological work in Bavaria (10 pages); a detailed description of the major areas of Bavaria—the Frankenwald, the Fichtelgebirge, and the northern Oberpfälzer Wald [each area is first described stratigraphically (pages 11 to 362) and later tectonically]; tectonic description of the last two areas (pages 435 to 447) follows an intermission, which is an elaborate description and discussion of the Münchberger gneis (pages 362 to 424). The lengthy treatment is well worthwhile since this gneis area has been mentioned and described in many basic papers on the granite problem.

The last part of Wurm's book consists of short chapters on special stratigraphic and tectonic problems, on the state of geophysical exploration (2 pages only), on the morphology of Bavaria (pages 463 to 488), and on mineral deposits (pages 489 to 540). This part is of particular value, since it mentions various basic publications and discussions which appear to be entirely unknown to the English-speaking geologist.

The list of localities at the end of the book is complete, whereas the index of subject matter is very incomplete with regard to both subject names and page numbers. The text is remarkably free of errors, and the figures are clear and well drawn.

As a whole, this book is an admirably complete handbook of one of the geologically best studied areas of Europe. It can be highly recommended to everyone who is interested in regional geology, or in basic problems of general geology.

G. C. AMSTUTZ
School of Mines and Metallurgy, University of Missouri

Reduced Status

The Ciliated Protozoa. Characterization, classification, and guide to the literature. John O. Corliss. Pergamon, New York, 1961. 310 pp. Illus. + plates. $12.

The author of this monograph is, needless to say, a specialist on ciliate taxonomy. He is, moreover, one of the few remaining protozoologists with patience enough to search the literature to the point of exhaustion (both of the literature and the author, and not infrequently of the reader). No work of this type is expected to be fascinating reading, and this one is no exception.

The first two parts deal with a modified scheme of classification, in which he places the Ciliates and the Suctoria together into a single class, the Ciliata.

His reasons for reducing the Suctoria to ordinal status are convincingly based upon the infraciliature, considered by him to be structures of "stable" importance. His proposed scheme will, I believe, be generally well received by protozoologists. Critical discussion of all valid genera of ciliates is given, and these genera are placed in the present scheme of classification. The third part of the monograph deals largely with a survey of the literature on ciliates—structural, functional, genetical, and biochemical.

For his citations Corliss has chosen approximately 1700 (out of his estimated 10,000 to 12,000) original papers, for which complete bibliographic references are given. This incredible number provides the serious student of protozoology with a key to virtually all that has been done with, and to, ciliated protozoans up to the immediate present.

This little book is in no sense a text, but it will be valued as a reference to references. The illustrations are excellent, diagrammatic, and far too few.

I suppose it is too much to hope that others with the competence and inclination of Corliss will complete the series with monographs on the other subphyla of Protozoa.

GEORGE W. KIDDER
Biological Laboratory, Amherst College

Ciba Symposium

Quinones in Electron Transport. G. E. W. Wolstenholme and Cecilia M. O'Connor, Eds. Little, Brown, Boston, Mass., 1961. xii + 453 pp. $11.

This important Ciba symposium was proposed by Karl Folkers of Merck & Co., for the purpose of discussing some of the new quinones being discovered in animals, microorganisms, and higher plants. As he says, "Nobody anticipated that the Liverpool studies on Vitamin A deficiency in rats, and the Wisconsin studies on lipid extracts of beef heart mitochondria which function in the electron transport activities of certain particles, would build a bridge into the field of photosynthesis of higher plants." It was Crane's studies on coenzyme Q_{10} in mitochondrial electron transport which led him and others to find related quinones in plants and to suggest that they may have a corresponding role in photosynthetic electron transport. As Folkers emphasizes, the new discoveries in this rapidly developing field open a never-ending expansion of new problems.

The volume opens with a discussion by R. A. Morton of the University of Liverpool on the isolation and characterization of ubiquinone (coenzyme Q_{10}), and this report is amplified by F. L. Crane of the University of Texas. The chemistry of ubiquinone and related compounds is discussed by O. Isler and his associates of Hoffmann-LaRoche of Basle. Folkers and his associates at Merck, Sharp & Dohme Research Laboratories describe organic and biological studies. All this information is then well summarized by David Green of the University of Wisconsin in discussing electron transport by means of ubiquinone.

The coenzyme Q group consists of 2, 3-dimethy-5-methylbenzoquinones with an unsaturated isoprenoid side chain in the 6 position, with from 6 to 10 isoprenoid units. When these units are 10, the compound is coenzyme Q_{10}, and because of its wide distribution in living material, is given the appropriate name "ubiquinone."

The symposium considers the biosynthesis of the Q coenzymes and their relationship to such fat-soluble vitamins as A and K. An important study by L. W. Wattenberg of the University of Minnesota, on the effects of ubiquinone and menadinone on oxidative enzymes in normal and neoplastic cells, suggests the possibility of applying some of the growing knowledge on ubiquinone to our understanding and control of malignant growth. A contribution by Norman Bishop of Florida State University clarifies the role of quinones in the electron transport system of photosynthesis.

The symposium was enlivened by vigorous discussion. It is clear that much verifiable information is now being obtained on some of the amazingly complex intermolecular reactions occurring within plant and animal cells which are involved in energy production and are dependent upon electron transport. The wide range and distribution of the coenzyme Q series suggests many potentially useful applications in the control of biological functioning. Here is an interesting example of how the essential unity of biological activity can be demonstrated even as the over-all science of biology becomes split ever more widely into narrow specialties. Equally interesting is the way in which basic scientific information on a detailed problem of biology can be brought together on an international level by good-willed cooperation between major drug companies and universities.

As Folkers emphasizes in closing, agreement on nomenclature for this important series of quinone compounds is essential. The good humor of this symposium is indicated by Folkers' closing tribute to F. L. Crane's dedication to science by having isolated one of the quinones from his Christmas tree!

CHAUNCEY D. LEAKE
Ohio State University

Inherited Personality?

National Character and National Stereotypes. vol. 1 of Confluence: Surveys of Research in the Social Sciences. H. C. J. Duijker and N. H. Frijda. Humanities Press, New York, 1961. xi + 238 pp. $4.50.

Throughout the 19th century and down to World War I there was a lively tradition of writing about the character of foreign nations and races. Perhaps the greatest work in this tradition is de Tocqueville's *Democracy in America*. In these studies "character" might be defined by any feature of society or culture such as politics, manners, even climate and geography, but in most there was at least the suggestion that national differences rest fundamentally on the distinctive psychological properties of ethnic and racial groups. More than that, these differences were assumed to be inborn and hereditary. Obviously such assumptions lent themselves to abuse. One could take them more lightly when they rested on nothing more than casual observation. As psychological measurement became more precise, however, the opportunity for abuse was greatly increased. Inevitably there were attempts to use intelligence tests to prove "scientifically" that Negroes were genetically inferior to whites. After World War I, psychology commendably purged itself of this aberration, as Otto Klineberg and others used these same tests to show rather dramatically how dangerous it is to make any assumptions about inborn and racial psychological differences.

Under the impact of this research, and in keeping with the liberal spirit of the 1920's and 1930's, the study of group differences in personality was widely regarded as smacking of racism, and it virtually disappeared as a field for serious investigation. In the United States during World War II a group of anthropologists, notably Ruth Benedict and Margaret Mead, reintroduced stud-

ies of national character as their contribution to the war effort. Their reports dealt mainly with the United States, Japan, and Russia, but some of the lesser nations were included as well. Drawing on a tradition of culture and personality studies done in primitive societies, they sparked a massive upsurge of interest in the study of national differences stated in psychological terms.

In this first of a series of surveys of research in the social sciences to be conducted with UNESCO support, two Dutch social scientists, Duijker and Frijda, assess what has been and what needs to be done in the study of national character. They review the confusing array of currently used approaches and conclude that the most distinctive and sound attack requires that we treat national character literally as the pattern of personality characteristics present in a given population. Only thus can we avoid confusing it with the people's history, their politics, or their institutions. This, of course, requires the use of psychological "tests" or measures which are valid cross-culturally, and our guides to the literature make it clear that there are not many which can qualify. It will be no great surprise, therefore, that Duijker and Frijda report that social psychologists have not yet, for even one country let alone for any set of nations, systematically described the distribution of personality characteristics in the population and assessed wherein the pattern is common or distinctive. The methods for such study are now more or less in hand, however, and we are convinced that with fuller resources the important factual questions facing the field can be answered. We cannot be equally confident that we will explain what produces differences in the psychological composition of populations—assuming such differences exist—or what consequences they have in social action.

There is a valuable bibliography of almost 1000 items. The bibliography, and several chapters which focus rather intently on a detailed review of the literature, make this essentially a specialist's book. Nevertheless, the presentation is very well organized, and the style commendably simple and lucid. The book will be read with interest by anyone willing to open his mind to the prospect of a scientific study of national differences.

ALEX INKELES
Russian Research Center, Harvard University

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

Admission Requirements of American Medical Colleges, Including Canada, 1961–62. Compiled by Helen Hofer Gee and E. Shepley Nourse. Assoc. of American Medical Colleges, Chicago, Ill., 1961. 244 pp.

Bulletin of Technical-Economic Information. State Scientific-Technical Committee of the Council of Ministers of RSFRS, Moscow, 1960. Translated by the National Science Foundation, Washington, D.C., 1961. 126 pp.

Collecting Science Literature for General Reading. Papers presented at an institute conducted by the University of Illinois Graduate School of Library Science, 6–9 November 1960. Frances B. Jenkins, Ed. Illini Union Bookstore, Champaign, Ill., 1961.

Drawings of British Plants. Being illustrations of the species of flowering plants growing naturally in the British Isles. pt. 16, *Compositae (2).* Stella Ross-Craig, Bell, London, 1961. 35 pp. 9s 6d.

Farm Policy for the Sixties. A statement by the NPA Agriculture Committee and a report by Lauren K. Soth. Natl. Planning Assoc., Washington, D.C., 1961. 25 pp. $1.

The First Man in Space. The record of Yuri Gargarin's venture into cosmic space. Press reports. Crosscurrents, New York, 1961, 79 pp. $0.50.

Glossary of Packaging Terms. Standard definitions of trade terms commonly used in packaging. Packaging Inst., New York, ed. 3, 1961. 176 pp. $3.50.

Grants, Loans, and Local Currencies. Their role in foreign aid. Robert E. Asher. Brookings Institution, Washington, D.C., 1961. 142 pp. Paper, $1.50; cloth, $2.50.

Institute in Technical and Industrial Communications. 1960 Proceedings. Herman M. Weisman, Roy C. Nelson, and F. Floyd Shoemaker, Eds. The Institute, Colorado State Univ., Fort Collins, 1961. 124 pp. $5.

International Directories of Education Teachers' Associations. UNESCO, Paris, 1961. Paper, $2.50. First publication in a new UNESCO series. Typical listing includes date of the Association's foundation, number of members, functions, and publications.

Laboratory Manual for General Microbiology. Jay V. Beck, Don H. Larsen, David M. Donaldson, and Richard D. Sagers. Burgess, Minneapolis, Minn., 1960. 59 pp.

A Laboratory Manual for Histology. James Forbes. Fordham Univ. Press, New York, ed. 2, 1961. 141 pp. $3.

La Vision en Lumière Intermittente Lois et mécanisme de la fréquence critique de fusion. Monographies Françaises de Psychologie, 8. Henri Piéron. Centre National de la Recherche Scientifique, Paris, 1961. 91 pp. NF. 8.50.

The New Media in Education. A report of the Western Regional Conference on Education Media Research, held at Sacramento, California, 20–22 April 1960. Jack V. Edling, Ed. Sacramento State College Foundation, Sacramento 19, Calif. 108 pp. $0.50.

New York Academy of Sciences. **Annals.** vol. 91, art. 4, "Automatic process monitoring," Franklin N. Furness, Ed., pp. 819–935. vol. 92, art. 2, "In vitro and in vivo effects of amino buffers," Franklin N. Furness, Ed., pp. 333–812. The Academy, New York, 1961.

The Optical Industry Directory. Optical Publishing Co., Lenox, Mass., 1961. 187 pp. Illus. $7.50.

Perspectives on the Conant Report. Social Science Research Center of the Graduate School. Univ. of Minnesota, Minneapolis, 1960. 107 pp.

Proceedings of the Uranium Carbide Meeting. TID–7603. Oak Ridge National Laboratory, Oak Ridge, Tenn., 1961 (order from Office of Technical Services, Dept. of Commerce, Washington, D.C.). 168 pp. $1.75.

Protozoan Parasites of Domestic Animals and Man. Norman D. Levine. Burgess, Minneapolis, Minn., 1961. 415 pp. Illus. $6.50.

Respiratory Metabolism in Plants. Harry Beevers. Row, Peterson, Evanston, Ill., 1961. 243 pp. Illus.

Rocket and Missile Technology. Chemical Engineering Progress Symposium Series, No. 33, vol. 57, 1961. G. C. Szego, Ed. American Inst. of Chemical Engineers, New York, 1961. 82 pp.

Scientific Resources in the Washington, D.C., Area, Directory, 1961–62. Science Bureau Metropolitan Washington Board of Trade, Washington 6, D.C. 63 pp. Illus. $2.

Scientists' Approaches to Information. ACRL Monograph, No. 24. Melvin J. Voigt. American Library Assoc., Chicago, Ill., 1961. 88 pp. $2.50. Reports a project carried out in Scandinavia to obtain information for planning the organization of scientific information and bibliographical aids.

Symposium on Microstructure of Proteins. C. G. Overberger *et al.* Interscience, New York, 1961. 175 pp. Illus. Presented at the 138th meeting of the American Chemical Society, September 1960; originally published in *Journal of Polymer Science* (44, No. 151).

Voluntary Health and Welfare Agencies in the United States. An exploratory study by an ad hoc Citizens Committee. Robert H. Hamlin, Director. Schoolmasters' Press, New York 27, 1961. 87 pp. $1.

U.S. Office of Education. **Reports.** No. OE-22012, "Influence of voter turnout on school bond and tax elections," Richard F. Carter and William G. Savard, 37 pp., $0.20. No. OE-54016, "Doctoral study, fellowship and capacity of graduate schools," John L. Chase, 65 pp., $0.45. No. OE-56006, "Enrollment and degrees in agriculture institutions of higher education, September, 1960," Henry S. Brunner, 75 pp., $0.45. Superintendent of Documents, Government Printing Office, Washington 25, 1961.

World Health Organization. **Public Health Papers,** No. 6, "Ionizing radiation and health," Bo Lindell and R. Lowry Dobson, 81 pp., $1, No. 7, "Basic nursing education programmes," 81 pp., $1. **Technical Report Series,** No. 219, "Arthropod-borne viruses," 63 pp., $1. WHO, Geneva, 1961 (order from Columbia Univ. Press, New York).

Colonial Growth of Neurospora

Sorbose and enzymes alter the composition of the cell wall and induce morphological changes.

Noël de Terra and E. L. Tatum

Abstract. L-Sorbose, an agent which induces colonial growth in *Neurospora crassa*, also induces structural changes in the cell wall. Acid hydrolyzates of cell walls isolated from sorbose-grown (colonial) hyphae contain more glucosamine and less glucose than do hydrolyzates of cell walls obtained from normally growing hyphae. Snail digestive juice, an agent which effects a structural change in the cell wall of *N. crassa* by liberating from it large quantities of glucose, has been found to induce colonial growth.

In 1949 Tatum *et al.* (*1*) described the induction of colonial growth in *Neurospora* by addition of L-sorbose or certain surface-active agents to the culture medium. The vegetative hyphae of *N. crassa* normally exhibit the growth pattern shown in Fig. 1*a*, in which branching occurs at intervals behind the hyphal tip. The hyphae are bounded by a cell wall and divided by incomplete crosswalls into cylindrical, multinucleate cells. In the presence of L-sorbose or other of the so-called "paramorphic agents," the mycelium grows in dense colonies consisting of very short cells (Fig. 1*c*). The amount of branching is greatly increased, with branches frequently occurring at the hyphal tip itself, a phenomenon infrequently seen in normally growing cultures. Many colonial mutants of *N. crassa* have been described (*2*).

The cell wall must obviously play a crucial part in determining the morphology of *Neurospora*, for spherical, osmotically sensitive protoplasts may be formed from *Neurospora* hyphae by treatment with snail digestive juice (*3*), a mixture of enzymes in which carbohydrases predominate (*4*). Work on bacteria has shown that characteristic aberrations in morphology can occur in the presence of agents thought to interfere with cell wall metabolism (*5*). One might suspect that specific deviations from normal cell wall structure in *Neurospora* could give rise to equally specific deviations in morphology and growth pattern, such as those found in colonially growing hyphae. In order to investigate this possibility, the cell walls of normal and colonial (sorbose-grown) hyphae were compared with respect to carbohydrates released by acid hydrolysis; using the opposite experimental approach, we attempted to induce characteristic changes in morphology and growth pattern by exposure of normally growing hyphae to an enzyme preparation capable of producing a structural change in the cell wall.

The authors are members of the Rockefeller Institute, New York.

Analysis of Reducing Sugars

Young, healthy mycelia of wild-type strain SYR 9-7a were grown in liquid culture on 0.2 percent sucrose-minimal medium (*6*), with and without addition of 4 percent sorbose. The mycelial pads were rinsed, lyophilized, pulverized in a mortar, and extracted for 15 to 20 hours with 1-percent deoxycholate. This treatment yielded cell wall preparations which were almost always free of cytoplasm, as judged by microscopic examination. The occasional contaminated preparations were discarded. The walls were then rinsed several times with distilled water, passed up through a graded alcohol series, and dried out of absolute ethanol. Ten-milligram samples were hydrolyzed for 30 min in a water bath at 100°C in 1 ml of 3*N* HCl. After removal of the residue by centrifugation, the hydrolyzate was depleted of excess HCl by flash evaporation and made up to 2 ml. One-tenth-milliliter aliquots were analyzed by paper chromatography, by use of an *n*-butanol–propionic acid–H_2O solvent; reducing sugars were detected with a *p*-anisidine spray (*7*). Chromatograms of wall hydrolyzates from normal and colonial (sorbose-grown) hyphae, prepared according to the methods described above, revealed the presence of only two sugars, glucose and glucosamine. These findings are similar to those obtained by other workers who have examined the cell wall carbohydrates of *Aspergillus* (*8*) and *Allomyces* (*9*, *9a*).

The glucosamine spot suggested the presence of chitin; this was confirmed by use of a modification of the Van Wisselingh test for chitin (*10*), which was applied to wall material isolated from normal and colonial (sorbose-grown) hyphae.

The presence of a polymer containing only glucose was revealed by incubation of isolated cell walls of normal hyphae with snail digestive juice (Industries Biologiques Françaises). Paper chromatography of soluble sugars in such digests revealed that large quantities of glucose had been liberated from the isolated walls. All other reducing sugars were absent, including N-acetylglucosamine. Tests in which purified chitin was incubated with snail digestive juice and the supernatant solution examined by paper chromatography showed no release of N-acetylglucosamine, and thus suggested that the particular preparation of snail digestive juice used in these experiments did not contain an active chitinase.

These results suggest that at least two carbohydrate polymers are present in the cell wall of *N. crassa*. The existence of more than two polymers cannot be excluded by the information obtained so far.

Aliquots of acid hydrolyzates prepared from isolated cell walls of normal and colonial (sorbose-grown) hyphae were quantitatively analyzed for glucose and glucosamine. Glucose was determined by a colorimetric test utilizing diphenylamine (*11*, p. 78) and glucosamine by the method of Dische and Borenfreund (*11*, p. 98). The results presented in Table 1 show a chemical difference between the cell walls of normal and sorbose-grown hyphae. With respect to sugars liberated by a 30-min acid hydrolysis, the walls of colonial (sorbose-grown) hyphae contain 184 percent as much glucosamine and 68 percent as much glucose as do the walls of normally growing hyphae. The ratio of glucosamine/glucose was 0.12 for normal hyphae and 0.32 for sorbose-grown hyphae. The total amount of carbohydrate released by acid hydrolysis from the walls of sorbose-grown hyphae was ap-

proximately 80 percent of that released from the walls of normally growing hyphae. It is not yet known whether this difference is caused by variations in the quantity of some unknown wall component or by differences in the hydrolysis rates of the polymers which comprise the cell wall.

These results are of special interest in view of the well-known observation that the aerial hyphae of sorbose-grown colonies possess normal morphology, for this fact suggests that sorbose acts at the cell surface. The cytoplasm of the aerial hyphae is continuous with the cytoplasm of the colonial hyphae lying in contact with the agar, and the aerial hyphae cannot grow except by utilizing nutrients transported from these colonial hyphae. One might therefore think that if sorbose were acting inside the cells the morphological effect would be transmitted to the growing aerial hyphae through the colonial hyphae with which they are continuous. Another indication that sorbose may act at the cell surface comes from the preliminary experiments of Wilson (*12*), who observed that the growth of hyphae injected with sorbose was completely normal. Calculations showed the amount of sorbose injected to be greater than that normally found (by studies with C^{14}-sorbose) in hyphae during sorbose-induced colonial growth.

The induction of colonial growth by sorbose does not appear to involve a large-scale uptake or incorporation of this compound into the mycelium, for pre-formed mycelial pads (dry weight 5 to 6 mg) induced to grow colonially by transfer to a sucrose-sorbose-C^{14} medium contained an amount of radioactivity which indicated that approximately 1 μg of sorbose was present in the mycelium after 8 hours of growth in the presence of the labeled compound.

Induction of Colonial Growth by Snail Digestive Juice

Bachman and Bonner (*3*) have described the production of protoplasts in liquid cultures of wild-type *N. crassa* by snail digestive juice at a concentration of 10 percent. Their results show that snail digestive juice is presumably capable of weakening the *Neurospora* cell wall in vivo. The large-scale liberation of glucose from isolated walls by snail digestive juice has been described in the first section of this report. The induction of morphological changes in *Neurospora* by this agent is described in the following paragraphs.

Table 1. Sugars released by acid hydrolysis from 10 mg of isolated cell walls of strain SYR 9-7a. Values corrected for addition of water and removal of N-acetyl group during hydrolysis.

Sugars	Medium: 0.2% sucrose			Medium: 0.2% sucrose and 4.0% sorbose		
	Wall prep. 1	Wall prep. 2	Mean, 1 + 2	Wall prep. 1	Wall prep. 2	Mean, 1 + 2
Glucosamine (mg)	0.50	0.64	0.57	1.00	1.09	1.05
Glucose (mg)	4.90	4.61	4.76	3.06	3.46	3.26
Glucosamine + glucose (mg)	5.40	5.25	5.33	4.06	4.55	4.30
Ratio: glucosamine/glucose	0.10	0.14	0.12	0.33	0.32	0.32

Agar plates of 2-percent sucrose-minimal medium were made up with concentrations of snail digestive juice that increased by steps of 1 percent from 1 through 5 percent. To minimize denaturation, the digestive juice was not added until the agar had cooled to 55°C. Streptomycin and penicillin, which by themselves have no effect on morphology, served to prevent bacterial growth. Plates were then inoculated with a suspension of conidia from strain SYR 9-7a.

With increasing concentrations of snail digestive juice, there was a progressive decrease in colony diameter and a

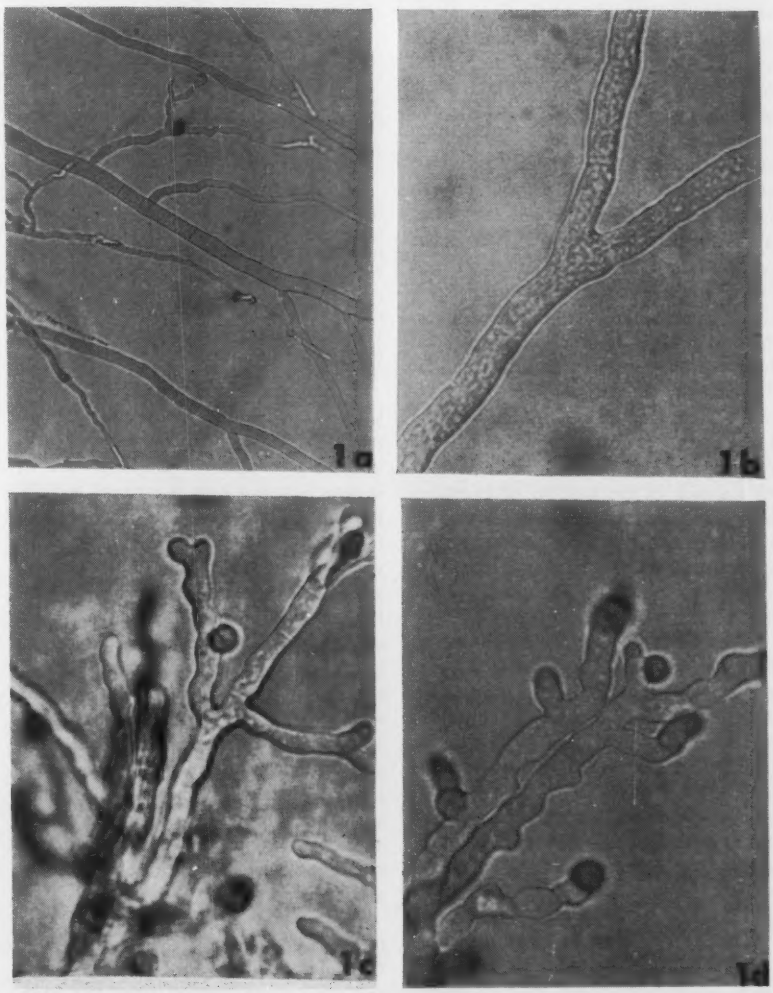


Fig. 1. *a*, Hyphae of wild-type strain SYR 9-7a growing on 2 percent sucrose-minimal agar (× 125). *b*, Same as *a* (× 500). *c*, Hyphae of wild-type strain SYR 9-7a growing on sorbose agar; 1.5 percent sorbose, 0.2 percent dextrose, 0.2 percent glycerol, minimal medium (× 500). *d*, Hyphae of wild-type strain SYR 9-7a growing on 2 percent sucrose-minimal agar containing 3 percent snail digestive juice (× 500).

corresponding increase in extent of branching until at a concentration of 5 percent (and to a somewhat lesser extent at 3 percent and 4 percent) the cultures were macroscopically indistinguishable from those grown in the presence of high concentrations of sorbose. Microscopically, the hyphae strongly resembled sorbose-grown hyphae (Figs. 1*c* and 1*d*), although marked variations in morphology and extent of branching were sometimes found in different parts of the same colony. The ability of snail digestive juice to induce colonial morphology declined with increasing age of the enzyme preparation. At a concentration of 10 percent snail digestive juice, growth did not occur. It is of special interest that all the typical features of colonial morphology as observed in sorbose-grown cultures can be induced by snail digestive juice, including initiation of branches at the hyphal tip, increase in branching, and some shortening of cell length. Growth was normal in the presence of autoclaved snail digestive juice, as well as serum albumin, N-Z-Case, and various proteolytic enzymes. Not enough is known about the mechanism by which branches are produced to explain these results, especially in view of the complex enzymatic content of snail digestive juice. In the absence of much sorely needed information, one can only speculate that a weakening of the cell wall by enzymatic digestion, in association with the high internal pressure known to exist in *Neurospora* hyphae (*12*), could lead to an increase in the number of branches initiated. The results described above suggest that sorbose may induce colonial growth in a similar manner, perhaps by inhibiting synthesis of the glucose polymer in the cell wall.

The results reported herein show that, in some cases at least, colonial morphology occurs in association with changes in cell wall structure. However, these observations cannot be placed in their proper perspective until further information is available on normal wall structure, cell wall metabolism in the presence of sorbose, and wall structure of some other colonial forms of *Neurospora*, notably the colonial mutants (*13*).

References and Notes

1. E. L. Tatum, R. W. Barratt, V. M. Cutter, Jr., *Science* **109**, 509 (1949).
2. C. C. Lindegren and G. Lindegren, *J. Heredity* **32**, 435 (1941); R. W. Barratt and L. Garnjobst, *Genetics* **34**, 351 (1949); A. M. Srb, *Heredity* **48**, 146 (1957).
3. B. J. Bachman and D. M. Bonner, *J. Bacteriol.* **78**, 550 (1959).
4. M. Holden and M. V. Tracey, *Biochem. J.* **47**, 407 (1950).
5. A. Tomasz and E. Borek, *Proc. Natl. Acad. Sci. U.S.* **46**, 324 (1960); M. C. Glick, T. Sall, F. Zilliken, *Biochim. et Biophys. Acta* **37**, 361 (1960).
6. F. J. Ryan, G. W. Beadle, E. L. Tatum, *Am. J. Botany* **30**, 784 (1943).
7. L. Hough, *Nature* **165**, 400 (1950).
8. A. G. Norman and W. H. Peterson, *Biochem. J.* **26**, 1946 (1932).
9. J. M. Aronson and L. Machlis, *Am. J. Botany* **46**, 292 (1959).

9a. *Note added in proof*: In M. R. J. Salton's *Microbial Cell Walls* (Wiley, New York, 1960), reference is made on page 20 to unpublished results, apparently of M. R. J. Salton and M. P. Hatton, reporting the presence of glucose and glucosamine in *Neurospora* cell wall polysaccharides.

10. H. Pringsheim and D. Kruger in *Handbuch der Pflanzenanalyse*, G. Klein, Ed. (Springer Verlag, Vienna, 1932, vol. 3, p. 72.
11. Gilbert Ashwell, in *Methods in Enzymology*, S. P. Colowick and N. O. Kaplan, Eds. (Academic Press, New York, 1957), vol. 3.
12. J. F. Wilson, unpublished data.

13. This work was performed during the tenure by N. de Terra of a U.S. Public Health Service postdoctoral fellowship of the National Cancer Institute.

21 June 1961

Measurement of the Relations between Chromosomes and Behavior

Abstract. The relations between the three major *Drosophila melanogaster* chromosomes and individual differences in geotaxis are assayed in populations selected for positive and negative geotaxis and in an unselected foundation population. The major changes which occur with selection and the differential roles in geotaxis of the three large chromosomes are described.

Experimental behavior genetics has usually been limited to selective-breeding and strain-comparison studies (*1*). In a few experiments the effects of known loci on behavior have been analyzed (*2*). Recently it has been found that it is feasible to study the relations between variations in sets of chromosomes and individual differences in behavior (*3*). Efficient, reliable, and objective methods developed for the observation of behavior in populations can now be combined in behavior genetic analysis with genetic techniques developed for assaying chromosomes. Such analysis can yield information about both the relative importance of particular chromosomes in producing individual differences in behavior and the nature of the relations between each chromosome and a behavior.

In the study reported here (*4*) the role in geotaxis of the three major *Drosophila melanogaster* chromosomes and their several interactions has been assayed with a multiple inversion tester stock (*5*) in a 2^3 factorial breeding experiment, reported in detail elsewhere (*6*). The chromosome assay method described by Mather and Harrison (*7*) depends on comparison of the geotactic effect of the chromosomes from a population under study with that of their homologues from a common tester stock. The homologous chromosomes of different populations under study can then be compared with one another by means of this common standard of reference. Direct comparison of the chromosomes from different populations is impossible because the chromosomes cannot ordinarily be identified and followed in segregation. The chromosomes of the tester stock contain inversions, however, which reduce recombination in heterozygotes; they also contain dominant morphological marker genes, which make it possible to follow in a backcross the segregation of these chromosomes from their homologues.

The assay breeding procedure consists of crossing a multiple inversion tester stock to the population being tested and then backcrossing the resulting F_1 hybrid to the same population. It produces individuals having either of two chromosome combinations for each of the three major *D. melanogaster* chromosome pairs. A pair of chromosomes is thus structurally either heterozygous or homozygous—that is, either the inversion chromosome from the standard tester stock is paired with its homologue from the tested population or both homologues come from the tested population. From the difference in geotactic behavior between the structural heterozygotes and the structural homozygotes an estimate is obtained of the geotactic effect of a given chromosome from a tested population.

The observations in this study are distributions of geotactic scores in the mass screening maze (*8*) for the eight combinations of structural heterozygotes and structural homozygotes produced by each assay. The maze affords objective, automatic, and reliable mass screening measurements of individual differences in both positive and negative geotaxis in populations under constant stimulus conditions.

Selective-breeding analysis (*6*, *8*) has previously shown that the variance in individual differences in geotaxis contains a large genetic component and that the sign of this taxis is a property of the individual genotype. Geopositive and geonegative populations have been developed by selection from a heterogenic foundation population (*6*, *8*) which has itself remained geotactically polymorphic while being maintained as

Table 1. Estimates, averaged over assay replications, of the differences in geotactic score between the structurally heterozygous and the structurally homozygous forms of the chromosome pair of a column for the population of a row. Rows (roman type): estimates and standard errors for geotactic effects of chromosomes; (*italic type*): differences between homologues from selected and unselected populations, with standard errors.

Chromosome		
X	II	III
Geopositive population		
1.39* ± 0.13	1.81* ± 0.14	0.12 ± 0.12
0.36 ± 0.24	*0.07 ± 0.19*	*0.41† ± 0.20*
Unselected population		
1.03* ± 0.21	1.74* ± 0.12	−0.29 ± 0.17
−0.56‡ ± 0.26	*−1.41§ ± 0.23*	*−0.78‡ ± 0.23*
Geonegative population		
0.47‖ ± 0.17	0.33 ± 0.20	−1.08‖ ± 0.16

Degrees of freedom: *17; †34; ‡35; §31; ‖18.

a free-mating population during selection of the two derived populations. For each population, ten replications were made of the assay. From most replications behavioral measurements were made on two samples of approximately 200 females each.

Table 1 presents (i) estimates and standard errors for the effects on geotaxis of the three chromosomes in the three populations; (ii) differences between estimates in the selected and unselected populations, with standard errors; and (iii) degrees of freedom from Student's t distribution for both the estimates and the differences which are significant ($P < .05$). Interactions among chromosomes were all negligible and are therefore omitted. The estimates are averages over assay replications of the differences in geotactic score between the structurally heterozygous and the structurally homozygous forms of the chromosome pair of a column for the population of a row.

The results of these experiments reveal the polygenic nature of individual differences in geotaxis. Genes on two chromosomes respond to selection for positive and for negative geotaxis; genes on another respond to selection for negative geotaxis only.

Selection studies have shown how large a part of the range of individual differences in geotaxis can be accounted for by differences in genotype. For the genetic background provided by the cross to the tester stock, the assay now shows (i) the extent of the difference between the selected populations attributable to differences in each of the three chromosomes; (ii) the different roles that the three chromosomes play in geotaxis; and (iii) how each chromosome in the two selected populations has changed in comparison with its unselected homologue in the foundation population. In the foundation population, chromosomes X and II contain factors which produce positive geotaxis, while chromosome III is slightly negative. All three chromosomes respond to selection for negative geotaxis: the positive effect of chromosomes X and II is markedly diminished, while the negative effect of chromosome III is considerably enhanced. In response to selection for positive geotaxis, chromosome III changes from negative to positive, chromosome II remains unchanged, and chromosome X has probably become slightly more positive. Clearly there are genes distributed over most of the genome which influence the response to gravity.

Analysis of the role of the chromosomes in behavioral variation suggests that it is now possible to specify with greater precision than ever before the structural basis of behavior. In organisms whose chromosomes are well mapped against their morphology, the chromosome map will suggest what structures intervene between a given chromosome and the behaviors with which it correlates. Furthermore, the chromosome-behavior correlations should contribute to the chromosome map, since each behavior will, in turn, suggest the structures that are involved in its execution.

L. ERLENMEYER-KIMLING
Department of Medical Genetics, New York State Psychiatric Institute, Columbia University, New York
JERRY HIRSCH
Department of Psychology, University of Illinois, Urbana

References and Notes

1. J. L. Fuller and W. R. Thompson, *Behavior Genetics* (Wiley, New York, 1960).
2. M. A. Bastock, *Evolution* **10**, 421 (1956); J. P. Scott, *Am. Naturalist* **77**, 184 (1943); C. Barigozzi and G. Tonissi, *Pontif. Acad. Sci. Commentationes* **10**, 431 (1946).
3. J. Hirsch, *J. Comp. and Physiol. Psychol.* **52**, 304 (1959).
4. We wish to thank T. Dobzhansky and F. J. Ryan for generously providing essential laboratory space and research facilities. This research was supported by grants No. G-3846, G-8998, and G-13595 from the National Science Foundation.
5. The multiple inversion stock used in the assays contains the inversions and mutants listed for stock No. 107 in the Yale stock list, *Drosophila Inform. Serv.* **32** (1958): *Sc*^{81} *B InS w*^{a} *sc*^{8}; *SMI Cy/Pm; Ubx/Sb*.
6. L. Erlenmeyer-Kimling, thesis, Columbia University (1961).
7. K. Mather and B. J. Harrison, *Heredity* **3**, 1 (1949).
8. J. Hirsch and L. Erlenmeyer-Kimling, *Science* **134**, 835 (1961).

22 June 1961

Reversal of Phenylalkylamine Tachyphylaxis by Norepinephrine

Abstract. Since the responses to "neurosympathomimetic amines" are reduced in the reserpinized animal and restored by norepinephrine administration, it was postulated that norepinephrine might also affect the development of their tachyphylaxis. We found that norepinephrine infusion restored, at least partially, certain tachyphylactic responses to amphetamine or ephedrine and fully prevented the development of tachyphylaxis to tyramine.

The class of drugs known as neurosympathomimetic amines (*1*) exhibit tachyphylaxis. These amines, for example ephedrine, amphetamine, or tyramine, which produce greatly reduced effects or no effects in chronically reserpinized animals, have been shown to release norepinephrine; the administration of norepinephrine in such animals may restore the responses to these amines (*2*). We showed that the pressor response to ephedrine, abolished by large amounts of cocaine, could be restored by the infusion of norepinephrine itself or by agents which act as norepinephrine-sparing compounds (*3*). Therefore, it was postulated that the loss of norepinephrine from critical sites might be the etiological factor in the development of neurosympathomimetic amine tachyphylaxis. Experiments discussed below were devised to test this hypothesis.

Four parameters were measured in male cats, weighing from 2 to 4 kg, anesthetized with α-chloralosé (80.0 mg/kg, intraperitoneally) and pretreated with atropine sulfate (2.0 mg/kg, intravenously) and with polygalacturonic acid glycoside (Mepesulfate, 10.0 mg, total dose): (i) mean arterial blood pressure, (ii) heart rate, (iii) tonus, and (iv) contractions of the nictitating membrane. Blood pressure from the carotid artery was recorded with a Sanborn transducer (No. 267B), and the nictitating membrane responses with Grass transducer (No. FT03) on a Sanborn four-channel polygraph. One femoral vein was canulated for the injections of the neurosympathomimetic amines, and the other for norepinephrine infusions. The nictitating membrane was set up for recording after removal of the lens.

To ascertain the rate and extent of tachyphylaxis development, control experiments were performed in six cats for each neurosympathomimetic amine studied (*4*). Hourly intravenous injections of *dl*-ephedrine sulfate (1.5 mg/kg) or *dl*-amphetamine sulfate (0.35

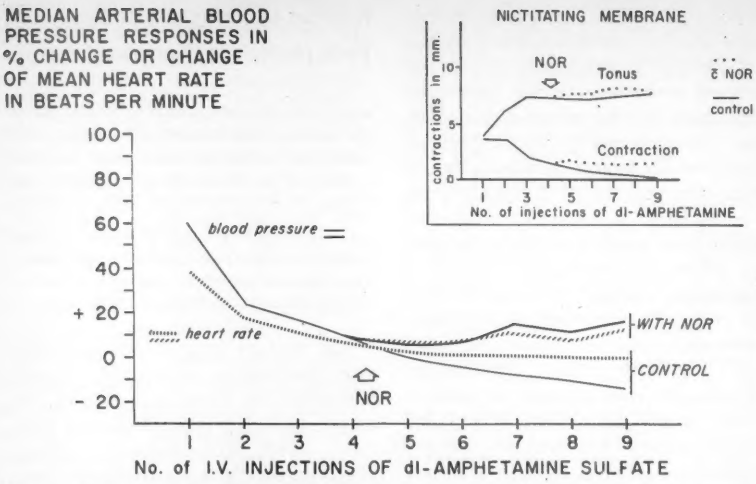


Fig. 1. *dl*-Amphetamine sulfate (0.35 mg/kg) was injected intravenously once every hour. In six cats (*CONTROL*) blood pressure, heart rate, and nicititating membrane contractions showed progressively reduced responses with repeated injections. Norepinephrine (*NOR*) infusion (0.83 μg/kg min) was started, indicated by the upward arrow, by the intermittent method in another six animals and hourly amphetamine injections continued (with *NOR*). Note the amphetamine effects on blood pressure, heart rate, and nictitating membrane contractions of the norepinephrine-infused animals as compared with the controls. Also note the unaltered increase of tonus of the nictitating membrane.

mg/kg) or one-half-hourly intravenous injections of tyramine hydrochloride (8.0 mg/kg) produced reliable tachyphylaxis in three of the four parameters measured—pressor effects, heart rate, and nictitating membrane contractions. Tyramine did not show tachyphylaxis of its effect on the heart rate. Both ephedrine and amphetamine increased the tonus of the nictitating membrane, whereas tyramine did not cause any change.

To test whether or not norepinephrine might influence the development of tachyphylaxis either in rate or extent, two methods for the administration of norepinephrine were employed: (i) either norepinephrine was infused for 30 min between the hourly injections of the tachyphylactogenic agent, starting after the fourth control response had been obtained (intermittent method), or (ii) norepinephrine was infused continuously, starting at zero hour. Amphetamine responses were obtained in six cats, using only the intermittent method of norepinephrine infusion (0.83 μg/kg per minute). The results are shown in Fig. 1.

It is obvious that the tachyphylaxis which had developed with the fourth injection of the drug was gradually reversed after several intermittent infusions. The tonus of the nictitating membrane, increased upon successive amphetamine injections, remained unaltered by norepinephrine. The augmentation of the pressor response and heart rate became statistically significant as early as the seventh injection of amphetamine, whereas the return of the nictitating membrane responses lagged behind, and the reinstitution of a statistically significant increased response was seen only with the ninth injection ($p < 0.01$ for all three parameters).

Using hourly intravenous injections of 2.5 mg/kg of ephedrine sulfate, norepinephrine infusion proved ineffective in reversing tachyphylaxis in five out of six cats. Significant results were obtained only when the dose of ephedrine was reduced to 1.5 mg/kg. With the latter dose schedule, tachyphylaxis could be as readily established as with the higher dose; and norepinephrine infusion, starting either at zero hour (2.5 μg/min) or after the full development of tachyphylaxis (2.5 μg/min), proved effective in either delaying the development of tachyphylaxis or in reversing the complete tachyphylactic responses to ephedrine.

The infusion of norepinephrine (2.5 μg/min) was started in six cats, before the administration of tyramine. The blood pressure responses under the influence of norepinephrine infusion were hardly changed, in contrast to the slow decrease in responses of the control animals, starting with the fourth half-hourly injection. The heart rate, as already mentioned, does not show tachyphylaxis to tyramine, and the nictitating membrane responses in the animals infused with norepinephrine were not measured.

It was found that the substitution of a pharmacologically similarly acting amine, phenylephrine, for norepinephrine increased rather than decreased the rate of development of tachyphylaxis. Thus, the mere infusion of a nontachyphylactogenic sympathetic stimulant or vasoconstrictor agent did not interfere with the development of tachyphylaxis. These observations further confirm the specificity of norepinephrine for the mechanism of tachyphylaxis.

The role of norepinephrine in tachyphylaxis must be different from its role in chronically reserpinized animals (*2*) since in the latter not only the responses to some sympathomimetic amines, but also to nerve stimulation are completely or partially lost. In our experiments, even at a time when amphetamine showed complete tachyphylaxis, the stimulation of the pre- or post-ganglionic fibers of the cervical sympathetic nerve elicited only slightly decreased contractions of the nictitating membrane. In other words, according to the terminology of Burn and Rand, the granular storage sites in the sympathetic nerve still contained adequate amounts of norepinephrine to induce responses obtained by nerve stimulation, despite the complete loss of reactivity to the tachyphylactogenic substances.

In summary, it appears that norepinephrine either prevents or partially restores the reduced responses seen with repeated administration of the three tachyphylactogenic neurosympathomimetic amines, amphetamine, ephedrine, and tyramine (*5*).

F. F. Cowan, C. Cannon*,
T. Koppanyi,
G. D. Maengwyn-Davies
Department of Pharmacology, Georgetown University Schools of Medicine and Dentistry, Washington, D.C.

References and Notes

1. A. Fleckenstein and D. Stöckle, *Arch. expil. Pathol. Pharmakol. Naunyn-Schmiedeberg's* **224**, 401 (1955).
2. J. H. Burn and M. J. Rand, *J. Physiol. (London)* **144**, 314 (1958).
3. C. Cannon, F. F. Cowan, T. Koppanyi, *Federation Proc.* **20**, 317 (1961).
4. F. F. Cowan, T. Koppanyi, G. D. Maengwyn-Davies, *Georgetown Med. Bull.* **14**, 199 (1961).
5. This work was supported in part by NFME-4, National Fund for Medical Education, and by B-1448, National Institute for Neurological Diseases and Blindness.

* Predoctoral fellow of the National Institute of Mental Health (MF-6837-C2).

7 July 1961

Interstitial Waters of Recent Marine Muds Off Cape Cod

Abstract. Interstitial waters of Recent muds off Cape Cod have salinities higher than the present ocean water in the same location and *p*H values lower than normal sea water in equilibrium with the atmosphere. The salinities may be either "paleosalinities" or an effect produced by behavior of the clay-water system as a semipermeable membrane. The low *p*H values are due to higher pressures of CO_2 in the sediment, probably coming from bacterial decomposition of organic matter.

On a recent cruise of the research vessel *Atlantis* of the Woods Hole Oceanographic Institution, several piston cores of bottom muds were taken and "squeezed" to remove the interstitial water. The stations occupied were all in the vicinity of 41°55′N, 69°30′W, in a small area of Recent grey muds several miles off Nauset light on the outer part of Cape Cod. Two layers were penetrated, a section of grey, slightly silty homogeneous clay, 1 to 6 m thick, at the top, and a section of brown and grey sandy and pebbly clay, at least 2.5 m thick, below. The upper grey clay contains a few marine mollusk shells, and is estimated to contain 2 to 5 percent $CaCO_3$. The lower brown sandy clay contains many carbonaceous fragments. Tentatively, the lower zone is correlated with the late Pleistocene, and the upper with the Recent. An oxidized transition zone of about 30 cm separates the two zones.

Samples of the cores were squeezed in a modified filter press of special design (*1*) to extract the interstitial water. The Na^+ activity of these waters and the bottom sea water, hereafter called "sodium-ion," were measured by a Na^+ sensitive glass electrode. This electrode should have no interference by other ions in sea water or interstitial water (*2*). Differences of electromotive force between standard Copenhagen water and the unknowns were read to ± 0.05 mv; it is estimated that the ratios reported are accurate to ± 1 percent of the number given. Chlorinity of the same samples was determined by $AgNO_3$ titration (Knudsen method). In addition, some *in situ* measurements of sodium-ion were made by pushing the glass electrode into the soft sediment. The values of sodium-ion determined by direct *in situ* measurement and by determinations on the squeezed waters are much the same.

Sodium-ion and chlorinity of bottom sea water and interstitial water plotted against depth in one core is shown in Fig. 1; the values are given as ratios to standard Copenhagen water (chlorinity = 19.374). The bottom water in this area is considerably less saline than that of the normal open sea throughout the year, mainly because fresh water funnels out of the Gulf of Maine past Cape Cod. The interstitial waters are all higher in sodium-ion and chlorinity than the overlying sea water, but less than Copenhagen water. The $\text{sodium-ion}_{sample}/\text{sodium-ion}_{standard}$ and $\text{chlorinity}_{sample}/\text{chlorinity}_{standard}$ ratios are in good agreement except for the bottom sea water, in which the $\text{sodium-ion}_{sample}/\text{sodium-ion}_{standard}$ is appreciably lower than the $\text{chlorinity}_{sample}/\text{chlorinity}_{standard}$.

The salinity change between bottom water and interstitial water may be explained by one of two alternatives. One is that some process is operating that is concentrating the salts in the sediment as the water of compaction is expressed upwards. It may be considered that the compacting clay-water system acts as a semi-permeable membrane, and only water is expressed, the hydrated ions being held behind.

An alternative is that this water is trapped unmodified sea water, and the salinities are "paleosalinities" (*3*). If this were so, it would suggest that the sediments accumulated in the past, when the hydrographic situation affecting sea water composition was somewhat different than that of today. For example, the sediments might have been accumulating during a time of decreased precipitation that resulted in less fresh water dilution from the Gulf of Maine than at present.

The choice between these alternatives can be made more easily after the completion of studies in progress on the behavior of clay-water systems under pressure as semi-permeable membranes and after more oceanic sediments are sampled to see if the effect is general or restricted to this area.

Determinations of *p*H by ordinary glass electrode were made *in situ* and on the expressed interstitial waters. The results showed that the *in situ* *p*H ranges from 7.4 to 7.8, whereas in the interstitial waters which were aerated in the squeezing process, it ranges from 8.1 to 8.2, a figure one would normally expect from sea water in equilibrium with the atmosphere. The simplest explana-

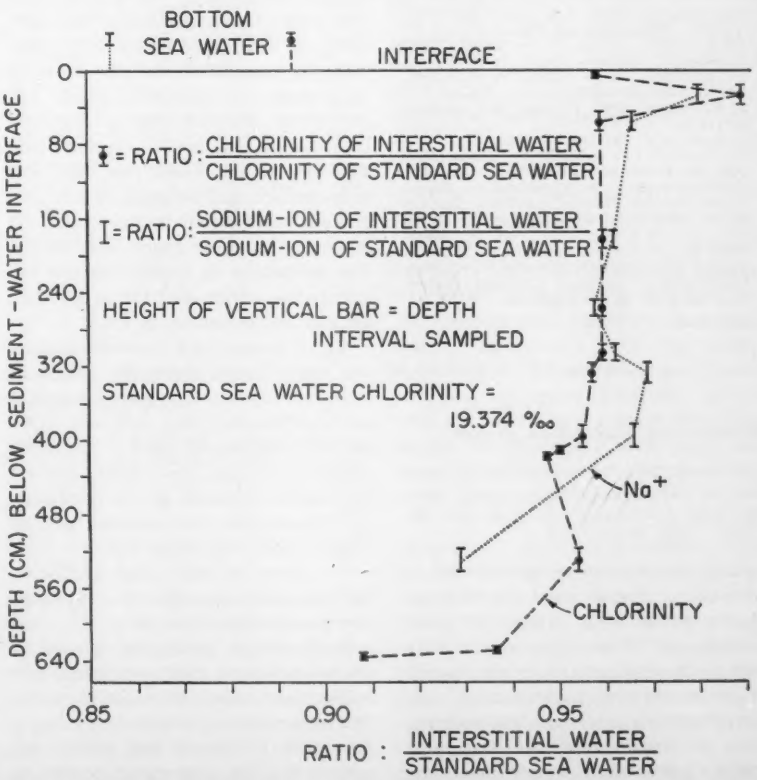


Fig. 1. Sodium-ion and chlorinity of bottom sea water and interstitial water plotted against depth.

tion for this discrepancy is that the CO_2 pressure in the sediment is higher than that in equilibrium with the atmosphere, and it is this that keeps the *p*H down. A calculation of the CO_2 pressure based on the *p*H change indicates that CO_2 pressure in the sediment is almost ten times that of the atmosphere. Measurements with a glass electrode, with a saturometer technique (*4*), indicated that the *in situ* sediment water is saturated with respect to $CaCO_3$ (calcite). The increased CO_2 is most likely the result of bacterial oxidation of organic matter. If this is so, CO_2 apparently diffuses upward through the sediment too slowly to allow the sediment to equilibrate with the overlying sea water, which, at this location, is almost certainly close to equilibrium with the atmosphere. Saturation with respect to calcite indicates that the solid carbonate shells are quick to equilibrate with the increased CO_2 by dissolving slightly (*5*).

RAYMOND SIEVER, ROBERT M. GARRELS
JOHN KANWISHER, ROBERT A. BERNER
Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, and
Harvard University, Cambridge, Massachusetts

References and Notes

1. R. Siever, *J. Sediment. Petrol.*, in press.
2. G. Eisenman, D. O. Rudin, J. U. Casby, *Science* **126**, 831 (1957).
3. B. Kullenberg, *Medd. Oceanog. Inst. Göteborg* **6**, (1952).
4. P. K. Weyl, *J. Geol.* **69**, 32 (1961).
5. This research was supported by various grants from the Petroleum Research Fund, American Chemical Society; the Committee on Experimental Geology, Harvard University; The Office of Naval Research, under Contract NONR 2196 (00), NR 083 (004); and the Woods Hole Oceanographic Institution. This paper is Contribution No. 1168 from the Woods Hole Oceanographic Institution. Chlorinity analyses were made by D. R. Waldbaum.

3 May 1961

Spontaneous Ejaculation in Rat

Abstract. Daily seminal discharges were observed when individually caged male rats were prevented from grooming the genital region orally.

Seminal ejaculation in the rat is believed to depend upon genital stimulation derived from a series of intromissions (*1*). Few observations have been made of ejaculation in the absence of penile stimulation. Aronson (*2*) observed erection and ejaculation during sleep in the domestic cat. But these events were often accompanied by pelvic movement. We have recently observed spontaneous ejaculations in hooded and albino rats after bilateral damage to amygdala and hippocampus primarily, but also after damage to septum, olfactory bulb, hypothalamus, and cortex (*3*).

Table 1. Daily ejaculations and penile smears of ten albino rats.

Animal	Seminal plugs/days of observation		Penile smears		
	Rats unrestrained	Rats girdled	Percent of 11 smears, taken during daylight, containing sperm; rats unrestrained	Presence of sperm in one smear taken nocturnally; rats unrestrained	Presence of sperm in one smear taken during daylight; rats girdled
5	2/20*	3/1	9	Yes	Yes
11	0/20	1/1	18	Yes	Yes
14	1/20	1/1	36	Yes	Yes
16†	27/20‡	2/1‡	0	No	No
17	1/20*‡	2/1	82	Yes	Yes
18	0/19	4/2	45	Yes	Yes
21	1/19‡	4/2	45	Yes	Yes
27	5/20	2/1	0	Yes	Yes
30	0/20	1/1	73	Yes	Yes
31	0/18	3/3	82	Yes	Yes

* Plugs were partly visible at the penis and were removed with forceps. † In this rat, each testis was about one-quarter the normal weight. Microscopic examination revealed no evidence of spermatogenesis. ‡ No sperm were found on microscopic examination.

The unoperated rat reveals a similar though lower incidence of spontaneous ejaculation. The data are based upon daily counts of seminal plugs deposited on the service pan which was lined with paper toweling. These plugs, consisting of coagulated semen, were verified microscopically, and the presence or absence of sperm was noted. Ten albino rats obtained from the National Institutes of Health were observed over a 21-day period. These rats were sexually mature and weighed 220 to 260 g. Four were caged in pairs, and the remaining six were caged individually. The differences in caging had no differentiating effects, and the data for all ten rats are presented in Table 1.

Six of the ten rats deposited at least one seminal plug during the period of observation. One rat, No. 16, deposited no less than one plug each day. This rat had inordinately small testes, each weighing 0.35 g, and there was no histological evidence of spermatogenesis. Microscopic examination of the plugs revealed that four rats had little or no sperm in their plugs (including No. 16), while the other six had plugs which were full of sperm.

Penile smears of the ten rats, taken on 11 successive days during daylight hours, were examined microscopically. The smears were prepared by passing a glass slide across the end of the exposed penis. In eight rats, sperm was indentified in at least one smear. Nocturnal smears, however, all contained sperm with the exception of the smear from rat No. 16. This led us to believe that all rats must have spermatic discharges quite frequently and that the lack of positive penile smears during daylight hours must be due to oral grooming of the genital region. Coupled with this, the more frequent deposition of plugs by the rats with brain lesions suggested that a seminal discharge might be occurring periodically in all rats, unoperated as well as operated, and that the more fastidious rats, the unoperated ones, tend to remove the evidence by oral grooming.

To test this hypothesis, we restrained the ten rats from grooming. Each rat was encased in a plastic tube which served as a stiff girdle around the thorax and abdomen, thus preventing the rat from bending to groom the genital region orally. Table 1 shows that the girdled rats deposited at least one seminal plug each day. All plugs contained sperm except those of No. 16. Under similar restraint, a single penile smear taken during daylight revealed a positive smear in all rats, again excepting No. 16. In order to rule out mechanical stimulation by the girdle as a factor in ejaculation we muzzled rats with adhesive tape and found a similar frequency of plugs. Our hypothesis that all rats have spontaneous daily seminal discharges, and that they frequently groom away the evidence, was thus confirmed (*4*).

We have made similar observations on two additional colonies of rats under unrestrained conditions. Seventy-six Sprague-Dawley rats were observed over a 10-day period with confirmatory results. Sixteen rats deposited at least

one plug each, all containing sperm, and 70 showed positive penile smears. A number of hooded Long-Evans rats, observed in a less systematic way, gave similar results.

These figures for the incidence of seminal plugs are probably conservative. Many plugs must go unrecognized because of their small size. Some are no bigger than the head of a pin, and are yellow and translucent, while others are as large as a kernel of corn. Sometimes a plug is missed because of its flat shape (probably fashioned by lying against the side of the ensheathed penis).

Spontaneous ejaculations first appear in hooded rats when they are between 50 and 60 days old. Sperm is often found in these first plugs and in the penile smears at the same age. Rats 16 months old, our oldest, continue to ejaculate spontaneously.

Occasionally a rat will deposit seminal plugs repeatedly, day after day for weeks. When paired with a female, such a male will continue to ejaculate without intromission (the vaginal smears of the cage mate reveal an absence of cornified cells and sperm, thus ruling out intromission).

After castration of rats, the frequency of ejaculation tapers and ceases within 7 to 10 days. (Sperm continues to appear in the initial postcastration plugs.) Conversely, a daily injection of testosterone propionate (0.5 mg) seems to reduce the incidence of seminal plugs. These results are contrary to the known androgenic control of male sexuality. However, there is little evidence on the hormonal control of grooming, and I am inclined to argue that the level of testosterone may determine the extent to which the rat will groom the genital region orally. This may explain why the rat with abnormally small testes (No. 16) seemed to produce the most semen, when unrestrained.

As regards autonomic involvement (*5*), seminal plugs were found within 30 min after the injection of epinephrine (0.07 mg subcutaneously), and within 4 min after the injection of mecholyl (5 to 8 mg subcutaneously). Under neither condition was an erection seen.

In order to rule out visual and olfactory cues in eliciting the seminal flow, we have redistributed rats in cages and rearranged cages in the rack with no effect on spontaneous ejaculation.

We have investigated other species but have not indentified sperm in the smears of any of them. Our samples included mice, rabbits, cats, and monkeys. Only the mice, when restrained from grooming the genital region orally, deposited seminal plugs.

We cannot distinguish the spontaneously produced plugs from those produced during copulation. This raises the issue whether fertile copulation need involve a *triggered* ejaculation following a series of intromissions. The multiple intromissions may serve the function of maintaining genital contact until a *spontaneous* ejaculation takes place. Alternatively, the spontaneous seminal discharges may represent an overflow of seminal fluid. In this sense, it may be possible to distinguish between "ejaculation" and "discharge" (*6*).

J. ORBACH

Institute for Psychosomatic and Psychiatric Research and Training, Michael Reese Hospital, Chicago, Illinois

References and Notes

1. F. A. Beach, "Characteristics of masculine 'sex drive,'" in *Nebraska Symposium on Motivation, 1956*, M. R. Jones, Ed. (Univ. of Nebraska Press, Lincoln, 1956), vol. 4, pp. 1–32.
2. L. R. Aronson, *J. Comp. and Physiol. Psychol.* **42**, 226 (1949).
3. N. B. Schwartz and A. Kling, *Federation Proc.* **20**, 335 (1961).
4. Oral grooming was not affected by topical application of t. valerian to the genitals and by anesthesia (10 mg Nembutal intraperitoneally).
5. J. H. Semans, and O. R. Langworthy, *J. Urol.* **40**, 836 (1938).
6. This study was supported by research grant No. M-3830 from the National Institute of Mental Health, U.S. Public Health Service. I am indebted to Dr. Neena B. Schwartz for advice, to Dr. Theodore Schafer for permission to make observations on his Sprague-Dawley rats, and to Anita F. Block for technical assistance.

14 August 1961

Immunization to Schistosoma mansoni in Mice Inoculated with Radiated Cercariae

Abstract. Preliminary experiments indicate that mice inoculated with cercariae of *Schistosoma mansoni* that have been exposed to cobalt-60 radiation in the range of 2500 to 3000 rep develop immunity to reinfection with nonradiated cercariae.

Resistance in mice and monkeys to reinfection with *Schistosoma mansoni* has been demonstrated by several investigators (*1*). Other reported studies include attempts to induce immunity by the inoculation of animals with immune serum, use of killed worms, and injection with extracts or metabolites of the worms (*2*). Instead of employing killed worms or metabolic products of *S. mansoni*, we thought that immunity might be induced by inoculation of cercariae exposed to an amount of radiation which would produce sexual sterilization and yet allow the cercariae to migrate in the tissues of the host in order to exert an antigenic stimulus.

Previous investigators have demonstrated that animals will develop immunity to reinfection with certain helminths after a primary infection with radiated larvae [*Trichinella spiralis* (*3*), *Dictyocaulus viviparus* (*4*), *Haemonchus contortus* (*4*), *Ascaris suum* (*5*)].

In the present investigation, cercariae from the Puerto Rican strain of the snail, *Australorbis glabratus*, were employed. In the initial experiment, 22 Swiss mice were divided into five groups: four groups of four mice each and one group of six mice. Each animal was inoculated intraperitoneally with 300 cercariae of mixed sexes. The first group received nonradiated cercariae. The second group received cercariae exposed to 1000 rep (roentgen equivalent physical); the third group, cercariae exposed to 2500 rep; the fourth group, cercariae exposed to 5000 rep; and the fifth group, cercariae exposed to 7500 rep. Eight weeks after the inoculation all the mice were killed and their livers and mesenteric veins were examined for schistosomes according to the method of Yolles *et al.* (*6*).

In a second experiment, five like groups of mice were similarly inoculated with nonradiated and radiated cercariae. After 8 weeks, each animal was given a challenging infection of 300 nonradiated cercariae of mixed sexes. The animals were then killed and examined for schistosomes 4 weeks after the challenging infection. At the time the inoculated mice were challenged, members of a sixth group of uninoculated mice each received 300 of the nonradiated cercariae.

In the first experiment, the mean (geometric) number of schistosomes per mouse recovered from each group receiving cercariae radiated with 0, 1000, 2500, 5000, and 7500 rep was 51.5, 29.0, 1.5, 0, and 0, respectively (Fig. 1, top). In the second experiment, the mean number of schistosomes recovered per mouse, after challenge, from groups first inoculated with cercariae radiated with 0, 1000, 2500, 5000, or 7500 rep was 46.4, 33.8, 6.6, 27.3, and 38.2, respectively. The mean

Table 1. Number of schistosomes recovered from mice, each of which was initially immunized with one or two doses of 200 radiated cercariae and later challenged with 200 nonradiated cercariae.

Group	No. of mice	First inoculation: radiation dose (rep) to cercariae	Time schedule (weeks after first inoculation)			Average No. of worms recovered
			Second inoculation (3000 rep to cercariae)	Challenge with nonradiated cercariae	Mice killed	
A	5	0			7½	59.6
B-1	5	3000			8	0.8
B-2	5	3000		10	18	8.0
C-1	5	3000	7½		15½	0.4
C-2	5	3000	7½	13½	21	5.2

number of schistosomes recovered from the uninoculated mice that received only the challenge infection of 300 nonradiated cercariae was 58.0 (Fig. 1, bottom).

The first series of tests located the radiation doses applied to cercariae which would reduce or eliminate the yield of adult worms. Compared with the yield when no radiation was used, the mean number of worms was smaller at 1000 rep, was drastically reduced at 2500 rep, and was zero at 5000 rep and 7500 rep.

The second series tested the effectiveness of the inoculation in inducing immunity. The mean number of worms recovered from mice given a challenging infection showed that prior inoculation with cercariae exposed to 7500 rep was ineffective, while cercariae exposed to 5000 rep produced a small measure of immunity. Cercariae exposed to 2500 rep produced a marked immunity; the mean number of worms recovered from mice immunized with cercariae exposed to 2500 rep was only 6.6, compared to 58 for the nonimmunized controls. The number of worms recovered from mice which were challenged after receiving nonradiated cercariae or cercariae exposed to 1000 rep was high. However, we cannot say how many worms were the result of the first inoculation and how many were produced from the challenge.

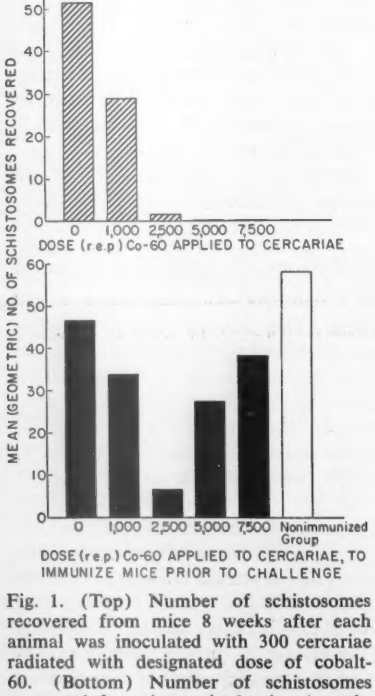


Fig. 1. (Top) Number of schistosomes recovered from mice 8 weeks after each animal was inoculated with 300 cercariae radiated with designated dose of cobalt-60. (Bottom) Number of schistosomes recovered from immunized mice 4 weeks after each animal was challenged with 300 nonradiated cercariae. Each mouse had been inoculated 8 weeks prior to challenge with 300 radiated cercariae with designated doses of cobalt-60.

In a third experiment, the effect of two inoculations of radiated cercariae was compared with that of one inoculation of radiated cercariae. The cercariae used in the inoculations had been exposed to 3000 rep. As before, nonradiated cercariae were employed for control experiments and to challenge the inoculated animals. Groups of five mice each were used. Mice in Group A were used as control animals which were inoculated only with 200 nonradiated cercariae; mice in group B-1 received one inoculation of 200 radiated cercariae each; mice of group C-1 received two such inoculations each, the second given 7½ weeks after the first.

The mice in group B-2 received one inoculation and those in C-2 two inoculations of radiated cercariae, and later were challenged with 200 nonradiated cercariae (Table 1).

In groups B-1 and C-1, single or double inoculations with radiated cercariae produced negligible average numbers of worms (0.8 and 0.4, respectively). When challenged with 200 nonradiated cercariae, the average number of worms from the mice inoculated once (B-2) was 8.0 and from those inoculated twice (C-2) was 5.2. The average number of worms recovered from the control group (A), inoculated only with nonradiated cercariae, was 59.6.

Examination of the few worms that developed from cercariae that received 3000 rep cobalt-60 showed that they were sexually sterile. Therefore, the inoculation of cercariae exposed to 3000 rep did not appear to produce an infection.

Examination of microscopic sections of the livers of animals which had received one or two inoculations of radiated cercariae, followed by a challenging infection with nonradiated cercariae, revealed no more than four eggs and granulomata in any section of liver. The control animals which received nonradiated cercariae yielded up to 50 eggs and granulomata per section of liver. Eleven microscopic sections of the small intestines of animals which received only the radiated cercariae showed one granuloma with an egg in only one animal, whereas in controls, 15 and 24 eggs and granulomata, respectively, were seen in two sections examined.

The results of this study indicate that mice inoculated with cercariae of *S. mansoni* which have been exposed to cobalt-60 radiation in the range of 2500 to 3000 rep develop immunity to reinfection with nonradiated cercariae.

Further experiments are being carried out with radiated cercariae to determine optimal conditions, such as dose of radiation, number of cercariae to be inoculated, and intervals of immunizing doses, for production of maximal degrees of immunity (*7*).

JOHN B. VILLELLA
HENRY J. GOMBERG
S. E. GOULD

Phoenix Memorial Laboratory and Department of Pathology, University of Michigan, Ann Arbor, and *Department of Pathology, Wayne County General Hospital, Eloise, Michigan*

References and Notes

1. L. Olivier and M. Schneiderman, *Am. J. Trop. Med. Hyg.* **2**, 208 (1953); M. A. Stirewalt, *ibid.* **2**, 867 (1953); H. E. Meleney and D. V. Moore, *Exptl. Parasitol.* **3**, 128 (1954); D. H. Naimark, A. S. Benenson, J. Oliver-Gonzalez, D. B. McMullen, L. S. Richie, *Am. J. Trop. Med. Hyg.* **9**, 430 (1960).
2. I. G. Kagan, *Rice Inst. Pam.* **45**, 151 (1958).
3. A. J. Levin and T. C. Evans, *J. Parasitol.* **28**, 477 (1942); J. R. Hendricks, *J. Elisha Mitchell Sci. Soc.* **68**, 12 (1952); S. E. Gould, H. J. Gomberg, F. H. Bethell, J. B. Villella, C. S. Hertz, *Am. J. Pathol.* **31**, 949 (1955); H. Zaiman, J. M. Stoney, J. Rubel, N. C. Headley, *Am. J. Hyg.* **61**, 5 (1955); C. W. Kim,

J. Elisha Mitchell Sci. Soc. **73**, 308 (1957); H. Zaiman, R. G. Howard, C. J. Miller, *Am. J. Trop. Med. Hyg.* **10**, 215 (1961).
4. W. F. H. Jarrett, F. W. Jennings, W. I. M. McIntyre, W. Mulligan, N. C. C. Sharp, G. M. Urquhart, *Am. J. Vet. Research* **20**, 522, 527 (1959).
5. J. B. Villella, H. J. Gomberg, S. E. Gould, *J. Parasitol.* **46** (suppl. Oct. 1960).
6. T. K. Yolles, D. V. Moore, D. L. DeGuisti, C. A. Ripsaw, H. E. Meleney, *J. Parasitol.* **33**, 128 (1947).
7. This investigation was supported by a grant from the Rockefeller Foundation, New York. We thank Dr. Henry van der Schalie of the University of Michigan for supplying us with snails and cercariae employed in this study.

6 June 1961

Senescence Inhibition and Respiration

Abstract. Freshly harvested asparagus spears treated with N^6-benzyladenine and then held in the dark at 21°C for 136 hours showed a lower respiration rate, as measured by CO_2 evolution, than nontreated spears. Associated with the lower respiration rate were proportional decreases in postharvest spear elongation and weight loss through desiccation.

Since the discovery of the biological activity of kinetin (6-furfurylaminopurine) in cell division (*1*), many studies have been made in which this and similar compounds have been evaluated in cell division of tobacco tissue, germination of lettuce seeds, and cell enlargement in leaf disks of radish (*2*). In addition, some rather striking effects on protein metabolism, chlorophyll breakdown, and the capacity of excised leaves to withstand stress have been reported (*3*). N^6-benzyladenine, a compound in which the furan ring in kinetin has been replaced by a benzene ring, has shown some effect in preventing postharvest breakdown of head lettuce when applied shortly before harvest or as a postharvest dip (*4*). This compound reportedly has a similar effect on other green vegetables, including asparagus (*5*).

Freshly harvested asparagus spears were obtained from a commercial processor and held for 24 hours at 5°C; the apical ends were trimmed to 5-inch length and then dipped in a $5 \times 10^{-5}M$ solution of N^6-benzyladenine or water. Eight 500-g samples of the treated spears and like samples of nontreated spears were placed in respirometers (*6*) and held in the dark at 21°C. The CO_2 evolution was measured every 8 hours for 136 hours, whereupon the spears were removed and their weight loss and length were determined.

The observed mean values and the fitted regression lines describing CO_2 evolution in treated and nontreated asparagus spears (Fig. 1) indicate that treatment with N^6-benzyladenine materially decreased respiration. Theoretical values of total CO_2 evolution during the 136-hour interval, obtained by integration of the regression equations, were 303 mg/kg for the nontreated and 257 mg/kg for the treated spears. These calculated values correspond very closely to the observed values of 295 and 253 mg/kg. The area between the curves constitutes the total respiration inhibition. This calculation yielded a value of 48 mg of CO_2 per kilogram, indicating about a 16-percent reduction in respiration through the first 120 hours in the N^6-benzyladenine-treated samples. Observed values for these differences were 47 mg of CO_2 per kilogram and 16 percent, respectively. After 120 hours, the nontreated samples evolved CO_2 at a lesser rate than did the treated, as a probable consequence of an initially more rapid depletion of the metabolites in the nontreated samples.

Weight losses in 136 hours were 7.25 and 5.95 percent in the nontreated and treated samples, respectively. Though the differences in weight loss were largely a function of the degree of desiccation, it is noteworthy that the decrease in water loss of approximately 18 percent in the treated samples was comparable to the decrease in respiration. Furthermore, nontreated spears elongated an average of 8.2 percent, and treated spears, of 7.0 percent. This difference (15 percent less elongation in the N^6-benzyladenine-treated spears) was again directly proportional to the amount of respiration inhibition.

These data suggest that respiration as measured by CO_2 evolution, desiccation as measured by weight loss, and growth as measured by elongation are all proportionally inhibited in harvested asparagus spears following postharvest application of N^6-benzyladenine.

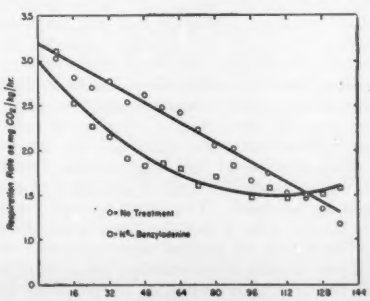


Fig. 1. Respiration of treated and nontreated asparagus held in the dark at 21°C.

It is further suggested that many of the phenomena observed by others, such as chlorophyll retention, changes in nitrogen metabolism, and general inhibition of senescence in green plant tissues subsequent to treatment with kinetin and related compounds, may be a consequence of respiration inhibition of the type described in this report (*7*).

R. R. DEDOLPH
S. H. WITTWER
V. TULI

Department of Horticulture, Michigan State University, East Lansing

References and Notes

1. C. O. Miller, F. Skoog, M. H. Von Saltza, F. M. Strong, *J. Am. Chem. Soc.* **77**, 1392 (1955).
2. C. O. Miller, *Ann. Rev. Plant Physiol.* **12**, 395 (1961).
3. K. Mothes, *Naturwissenschaften* **47**, 337 (1960); A. E. Richmond, and A. Lang, *Science* **125**, 650 (1957).
4. P. M. Bessey, *Ariz. Univ. Agr. Expt. Sta. Rept. No. 189* (1960), p. 5.
5. Shell Development Company, Modesto, Calif.
6. L. L. Claypool and R. M. Keefer, *Proc. Am. Soc. Hort. Sci.* **40**, 177 (1942).
7. Journal article No. 2837 of the Michigan Agricultural Experiment Station.

3 July 1961

Explanation of Cocaine Desensitization of Blood Pressure Responses to Ephedrine

Abstract. It is suggested that cocaine desensitizes ephedrine blood pressure responses by depletion of norepinephrine depots. This was shown by reversing cocaine desensitization through the administration of agents such as bretylium, which has a sparing effect on norepinephrine, and by the infusion of norepinephrine itself.

A number of workers (*1*), since the original discovery by Tainter (*2*), have shown that cocaine in large doses diminishes or abolishes the pressor responses to ephedrine. The exact mechanism of this antagonism has not been explained. We therefore attempted in the present study (*3*) to elucidate this phenomenon according to the theory of one of us (T.K.). This theory postulates that large doses of cocaine exhaust the sympathetic neurohumor depots and, owing to this mobilization, may change physicochemical parameters of cellular membranes (*4*). Therefore, three alternatives were considered: ephedrine should be protected from cocaine desensitization by the administration of (i) substances which prevent such neurohumoral release, or (ii) substances which protect the neurohumor from metabolic destruction, or (iii) the neurohumor itself.

Male mongrel dogs, weighing from 6 to 10 kg, were anesthetized intraven-

ously with sodium pentobarbital (30.0 mg/kg). Blood pressure was recorded from one carotid artery with the usual hemodynamic setup. Both femoral veins were canulated for either drug injection or infusion. Polygalacturonic acid glycoside (Mepesulfate, 20.0 mg, total dose) was injected intravenously as an anticoagulant. Additional doses of 10.0 mg each were given at hourly intervals, as needed; the arterial pressure system was filled with a 0.25 percent solution. All dogs were given atropine sulfate (2.0 mg/kg), intravenously, after this procedure, to prevent reflexes mediated by parasympathetic nerves. Doses of *dl*-ephedrine sulfate were administered at hourly intervals, in volumes constant for each experiment, and flushed in with 2.0 ml of physiological salt solution. All other drugs were administered intravenously excepting cocaine (20.0 mg/kg), which was injected subcutaneously exactly 30 min after the first or third control injection of ephedrine. An interval of 30 min was allowed to insure sufficient time for the absorption of this drug. Additional drugs used in these experiments were given either 15 min before or 45 min after the injection of cocaine. A nontachyphylactic dose of racemic ephedrine salt, as reported by Tainter (*2*), was 0.5 mg/kg, and, therefore, was the dosage chosen for all of our experiments. Our findings, though, indicate a reduction in the pressor responses to ephedrine up to 33 percent after three consecutive hourly injections. The first three hourly responses to ephedrine showed no significant difference. Nevertheless, the reduction in ephedrine pressor effects caused by such a "tachyphylaxis" is not comparable to the depotentiation observed after the administration of cocaine, when pressor responses to ephedrine are reduced between 84 and 100 percent (Fig. 1).

In order to test the previously described theory of cocaine depotentiation of ephedrine pressor responses, we first tested the effect of two drugs, namely, bretylium tosylate (10.0 mg/kg), which is reported to inhibit norepinephrine release from storage sites (*5*), and chlorisondamine dimethochloride (0.3 mg/kg), a ganglionic blocking agent with prolonged duration of action (*6*), which inhibits passage of central sympathetic impulses, and, therefore, continuous release of norepinephrine from the nerve endings. Both drugs were administered to the animals exactly 15 min after the third hourly injection of ephedrine and before the subcutaneous cocaine. Both drugs produced an inhibition of cocaine desensitization of ephedrine pressor responses (Fig. 1). The differences represented in the bar graph are statistically significant; the probability of such a phenomenon being observed due to chance is less than 1 in 1000 for bretylium, and much less than 1 in 1000 for chlorisondamine.

Second, we injected the cocaine 30 min after the first control injection of ephedrine and then observed the depotentiation of the second hourly ephedrine injection, which was comparable to the fourth hourly injection after cocaine, as shown in Fig. 1. Pyrogallol (20.0 mg/kg), reported to be an O-methyltransferase inhibitor (*7*), was injected 15 min after this depotentiated second hourly injection of ephedrine. It progressively increased the subsequent hourly ephedrine responses (5th hour shown in Fig. 1). This reversal of ephedrine depotentiation by cocaine could have been observed by chance less frequently than 1 in 1000.

We finally tested whether or not infusion with the generally postulated sympathetic neurohormone itself could reverse cocaine desensitization. Norepinephrine (26 μg/kg per hour) was infused 15 min after the observed cocaine-desensitized ephedrine response, as described for pyrogallol. It can also be seen in Fig. 1 that norepinephrine itself counteracted cocaine desensitization to a highly significant extent (the chance probability of such an event is less than 1 in 1000).

Therefore, our theory that cocaine desensitization of ephedrine is caused by depletion of endogenous norepinephrine was confirmed. Lately, also, von Euler (*8*) stated that cocaine, in such large amounts, causes a depletion of this sympathetic neurohumor.

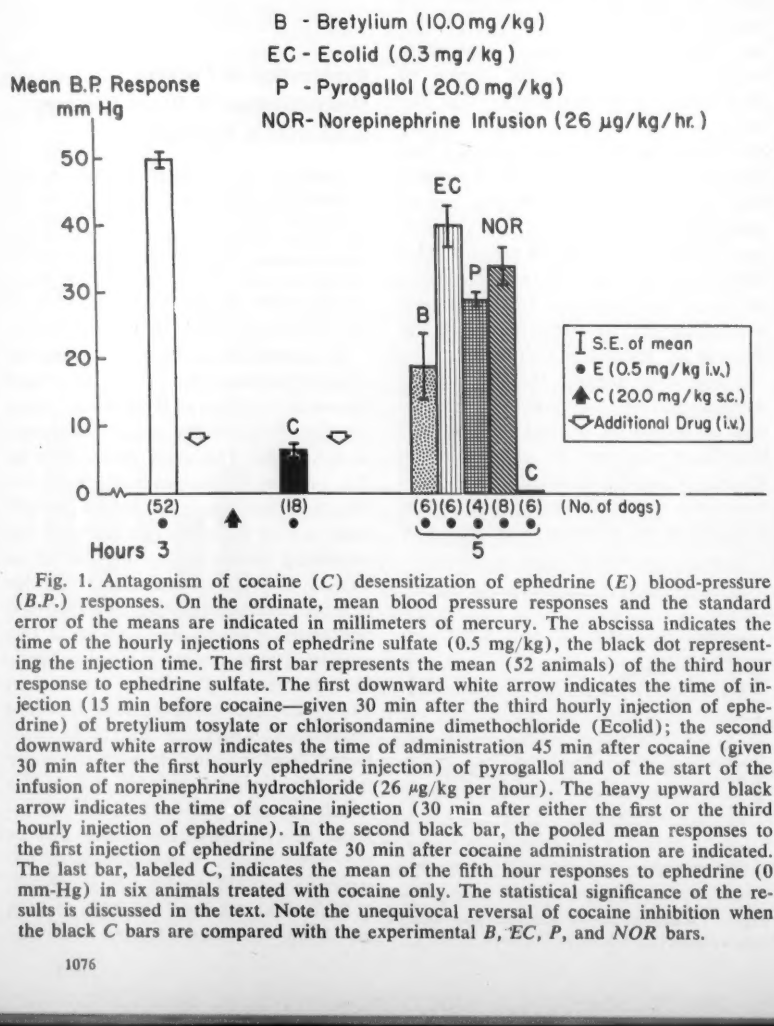


Fig. 1. Antagonism of cocaine (*C*) desensitization of ephedrine (*E*) blood-pressure (*B.P.*) responses. On the ordinate, mean blood pressure responses and the standard error of the means are indicated in millimeters of mercury. The abscissa indicates the time of the hourly injections of ephedrine sulfate (0.5 mg/kg), the black dot representing the injection time. The first bar represents the mean (52 animals) of the third hour response to ephedrine sulfate. The first downward white arrow indicates the time of injection (15 min before cocaine—given 30 min after the third hourly injection of ephedrine) of bretylium tosylate or chlorisondamine dimethochloride (Ecolid); the second downward white arrow indicates the time of administration 45 min after cocaine (given 30 min after the first hourly ephedrine injection) of pyrogallol and of the start of the infusion of norepinephrine hydrochloride (26 μg/kg per hour). The heavy upward black arrow indicates the time of cocaine injection (30 min after either the first or the third hourly injection of ephedrine). In the second black bar, the pooled mean responses to the first injection of ephedrine sulfate 30 min after cocaine administration are indicated. The last bar, labeled C, indicates the mean of the fifth hour responses to ephedrine (0 mm-Hg) in six animals treated with cocaine only. The statistical significance of the results is discussed in the text. Note the unequivocal reversal of cocaine inhibition when the black *C* bars are compared with the experimental *B*, *EC*, *P*, and *NOR* bars.

CAROLYN CANNON*, F. F. COWAN, T. KOPPANYI, G. D. MAENGWYN-DAVIES

Department of Pharmacology, Georgetown University Schools of Medicine and Dentistry, Washington, D.C.

References and Notes

1. F. De Eds, *Proc. Soc. Exptl. Biol. Med.* **24**, 551 (1927); P. S. Pittenger, *J. Am. Pharm. Assoc.* **17**, 634 (1928); P. V. Hammond, *J. Am. Pharm. Assoc. Sci. Ed.* **48**, 602 (1959).
2. M. L. Tainter and D. K. Chang, *J. Pharmacol. Exptl. Therap.* **36**, 569 (1929).

3. This work was supported in part by the National Institute for Neurological Diseases and Blindness (grant B-1448), and by the National Fund for Medical Education (grant NFME-4).

4. T. Koppanyi, *J. Pharmacol. Exptl. Therap.* **38**, 113 (1930).
5. A. L. A. Boura and A. F. Green, *Brit. J. Pharmacol.* **14**, 536 (1959).
6. J. H. Plummer, J. H. Trapold, J. A. Schneider, L. A. Maxwell, A. E. Earl, *J. Pharmacol. Exptl. Therap.* **115**, 172 (1955).
7. J. Axelrod and M. J. Laroche, *Science* **130**, 800 (1959).
8. U. S. von Euler, in *Ciba Foundation Symposium: Adrenergic Mechanisms*, G. E. W. Wolstenholme and M. Connor, Eds. (Churchill, London, 1960), p. 495.

* Predoctoral fellow of the National Institute of Mental Health (MF-6837-C2).

7 July 1961

Absence of the Diego Antigen, a Genetic Characteristic of Early Immigrants to South America

Abstract. The Diego blood group is an exclusive Mongoloid gene marker, although it is not present in all Mongoloid populations. The absence of the gene in Waica Indians and its very low frequencies in Warrau and Yaruro Indians of South America suggest that it represents a genetic characteristic of Marginal American Indians. Since Marginal Indians are considered to be early comers to the New World, we suggest that Diego-negative populations were the first to arrive and to extend throughout South America, while the Diego-positive tribes came later.

The Diego blood group antigen was first discovered in a Venezuelan family of Carib Indian ancestry (*1*). Subsequently it proved to be an exclusive Mongoloid gene-marker, which is not present in Caucasoids and Negroids. This evidence, however, does not imply that the gene is carried by all Mongoloid populations or that it is carried by them in a more or less constant frequency. On the contrary, studies during the last 6 years have shown that there exist populations which, while classified as Mongoloid, do not carry the gene at all—for example, the Oceanic populations, the Eskimo, and several Amerindian tribes (*2*).

In a recent review of all the populations examined for this antigen, it was observed that populations with related languages tend to show similar Diego frequencies. One of the best documented cases studied is that of three groups of Venezuelan Cariban tribes which showed a Di (a +) range between 20 and 34 percent (mean 28 percent), in spite of being separated from each other by some 3000 years (30 m.c.) in time and over a distance of 1500 km (*2*, *3*). Thus, linguistic affiliation, together with several specific culture aspects of the various tribes, has proved to be useful in predicting the Diego frequencies in Indian populations. Since the identification of extreme culture types is less complicated than that of intermediate ones, we directed our studies toward those tribes of South America which are conventionally classified as Marginal. Combining the physical anthropologists' notion of Marginal Indians with that of the cultural anthropologists, we understand here as being Marginal those aborigines of South America who are predominantly dolichocephalic, of medium or stocky build, with varying degrees of Mongoloid features, nonagricultural, with little developed technology, and a simple social structure based on kinship rather than on class. The purpose of our study was to find out whether Diego antigen frequencies would show marked differences between Indian populations of very different culture types.

Last April we had an opportunity to study the Waica Indians of southern Venezuela, whose identification as Marginals can hardly be doubted (*4*). As a subtribe of some 10,000 individuals, they belong to the Yanoama, who also include the Sanemá, Samatari, Kasapare, Surára, and Pakidái of southern Venezuela and northwestern Brazil; these various languages form a linguistic stock of 6 to 35 m.c. of internal separation.

Without going into the details of the results of antigen analysis of the ten blood group systems, we would like to report here the absence of Diego in 142 samples. They were taken from less closely related individuals living in six settlements within an extensive area. We consider, therefore, that this sample is a genetic representative of the entire Waica population and, in consequence, that it rules out the possibility that the Diego result is due to gene drift.

This finding is considered to be of major importance, because it raises the figure of Diego-negative Marginal tribes of Venezuela to the number of three—that is, Warrau, Yaruro, and Waica (Table 1).

The Warrau (*5*) occupy the Orinoco Delta and the adjacent swampy regions of the coast of British Guiana (latitude, 8°–10°N; longitude, 59°–62°W). Two different subtribes were tested, one of them a peripheral community, called Guayo, in which some admixture with the neighbouring Indian tribes was expected to have occurred (Carib, Arawak). The other one, the Winikina, live in the center of the Orinoco Delta, where they have been living in complete isolation until very recently. The Guayo-Warrau showed a Di^a gene frequency of 1.9 percent, and the Winikina-Warrau were negative.

The Yaruro (*5*) Indians inhabit the savannahs or *llanos* of southwestern Venezuela (7°N, 68°W). They have been living in this alternately desert-like and flood-covered territory for many centuries, and there are reasons to assume that they took possession of it long before the discovery of America. From 102 samples tested, only five demonstrated the Di^a, of which four were derived from 11 samples, taken from a single band. This indicates that they do not represent actually a homogenous pool of Di^a genes.

For the reasons mentioned above, we suggest that the Warrau as well as the Yaruro were Diego-negative originally, and that their low Di^a frequencies are due to admixture with the neighbouring tribes who exhibit a relatively high frequency of the gene.

Contrasting with the absence of the Diego gene among Marginals are the elevated frequencies of 10 to 45 percent of Diego among peoples of a higher culture level and different linguistic affiliation—that is, Saliva, Arawak, Tupí, Carib, Chibcha, Quechua, and Aymara—and who, according to their culture and physical type, fit into the scheme of Coon *et al.* (*6*), as either Tropical Forest Indians or Central American Indians. Exceptions, which expectedly have come up, were discussed by the authors in the case of the Tunebo, Irapa, Colla, and Omaguaca

Table 1. Distribution of the Di^a genotype in Marginal Indian tribes.

Tribes	No. tested	Phenotypes (%)		Genotypes (%)	
		Di (a+)	Di (a−)	Di^a	Di
Winikina-Warrau	72	0.00	100.00	0.00	100.00
Guayo-Warrau	81	3.69	96.31	1.9	98.1
Yaruro	102	4.91	95.09	2.49	97.51
Waica	142	0.00	100.00	0.00	100.00

(7), but in each of these cases sufficient cultural and genetic evidence could be accumulated to show that discrepancies in the relationship between Diego gene frequencies and culture development were due to acculturation rather than to gene drift or natural selection. For instance, the Colla and Omaguaca, who adopted the Quechua language during the Spanish conquest, showed 3 percent of Di (a +) while the true Quechua tribe tested exhibited 25 percent. Tunebo, although linguistically classified as Chibchan, exhibited an incipient agriculture, and their physical features differ from other Chibcha Indians. The Diego frequency was only 1 percent for the Tunebo, while two other Chibcha tribes tested, Ica and Páez, demonstrated 41 and 31 percent, respectively. The Irapa, a Yupa subtribe which in turn is of Cariban affiliation, exhibited 2 percent of Di (a +), and four other Yupa subtribes tested had a range from 21 to 34 percent; also, the Rh and MNSs of the Irapa were statistically different from the other Yupa subtribes, while similar to the Southern tribe (Dobokubi) which showed a negative incidence of Diego (8). We are not proposing, of course, that a gene is to be made responsible for a certain culture pattern. However, from a parallel study of cultural characteristics and Diego frequencies, it is becoming gradually clear that different culture types go along with different genetic constitutions. In particular, Marginal Indians differ in both cultural and genetic aspects from the Tropical Forest Indians and the Central American Indians. It is obvious that this observation, if substantiated by future research, will be of great importance for the historical reconstruction of the peopling of America. At the present stage of Diego research, we propose that the Diego-negative peoples represent an early wave of immigrants in South America, and that most of them can still be identified by a Marginal type of culture. They were possibly followed by Diego-positive peoples, whose earlier waves would have had a better chance of interbreeding with the Diego-negative tribes than their later ones, thereby causing the different frequency ranges (9).

M. LAYRISSE
Departamento de Fisiopatología, Instituto Venezolano de Investigaciones Científicas, Caracas, Venezuela
J. WILBERT
Fundación La Salle de Ciencias Naturales, Caracas, Venezuela

References and Notes

1. M. Layrisse, T. Arends, R. Domínguez Cisco, *Acta med. Venezuela* **3**, 132 (1955); M. Layrisse and T. Arends, *Science* **123**, 633 (1956).
2. M. Layrisse and J. Wilbert, *El antigeno del sistema sanguíneo Diego* (Editorial Sucre, Caracas, 1960).
3. M. Layrisse, Z. Layrisse, J. Wilbert, unpublished data.
4. O. Zerries, *Bol. Indigenista Venezolano* **2**, 61 (1954); H. Becher, *Mitt. mus. völkerkunde Hamburg* **26** (1960).
5. M. Layrisse, T. Arends, J. Wilbert, *Nature* **181**, 118 (1958); M. Layrisse, Z. Layrisse, E. Garcia, J. Wilbert, *Southwestern J. Anthropol.*, in press.
6. C. S. Coon, S. M. Garn, J. B. Birdsell, *Races; A Study of the Problems of Race Formation in Man* (C. C. Thomas, Springfield, Ill., 1950).
7. M. Layrisse, Z. Layrisse, J. Wilbert, *Am. Anthropologist* **62**, 418 (1960); ———, *ibid.*, in press; M. Layrisse, W. Best, R. Bermejo, in preparation; J. L. Scaro, *Rev. soc. arg. biol.* **34**, 71 (1958).
8. A. Nuñez Montiel and Ponce, *Congr. Salud Publica, Caracas* (1961).
9. This work was supported in part by Fundación Creole, Caracas. We are indebted to Zulay Layrisse and Esperanza García for technical assistance and to Dr. Ovidio Castellani (Malariologia, Territorio Amazonas) for his collaboration in the collection of blood samples.

26 June 1961

Effect of Deuteration of N—CH_3 Group on Potency and Enzymatic N-Demethylation of Morphine

Abstract. Substitution of deuterium for the N-methyl hydrogens of morphine produced a significant reduction in the potency and lethality of morphine in mice regardless of the route of administration. There was no effect on the time of onset, maximal effect, or duration of action. N-demethylation by rat liver microsomal enzymes was characterized by a smaller reaction rate constant, a higher energy of activation, and a larger Michaelis constant with respect to the deuterated morphine. These findings indicated that deuteration of the N-methyl group of morphine not only caused reduction in potency, but also a reduction in the rate of oxidative N-demethylation, and a distinct weakening of the binding to the enzyme active centers.

The role of demethylation in the action and metabolism of morphine-like analgesics has been the subject of much recent work. Beckett *et al.* (1) postulate that N-dealkylation at the central receptor site is the initial reaction in the production of analgesia, and Axelrod (2) has stressed the similarity between the receptors for these drugs and the N-demethylating enzyme present in the liver.

The process of N-demethylation appears to be an enzymatic oxidative reaction resulting in the breaking of a C—N and a C—H bond, as evidenced by formaldehyde formation (3). If the rate of demethylation is dependent on the ease with which the C—H bond is oxidized, and if the biological actions are a function of such N-demethylation, then a change in the C—H bonding force would similarly affect both phenomena. To test this hypothesis, morphine in which the N-methyl group has been completely deuterated has been prepared and studied in vivo and in vitro.

To prepare morphine—N—CD_3, normorphine was treated with excess ethyl chloroformate. The resulting N-ethoxycarbonyl group was reduced with lithium aluminum deuteride, giving morphine—N—CD_3, identical to the corresponding protium compound in melting point and ultraviolet absorption spectrum. However, the pK_a of morphine—N—CD_3 was found to be 8.17 as compared to 8.05 for morphine, thus making the deuterium compound a stronger base by 24 percent (4).

Alterations in the pharmacological activity of the resulting deuteriomorphine and/or in its oxidative N-demethylation by rat liver microsomal enzymes might suggest a relationship between the methyl group and drug action. Accordingly, the LD_{50}'s for morphine and deuteriomorphine were determined in swiss albino mice by the subcutaneous and intracerebral routes and the ED_{50}'s for analgesia as tested by the tail flick method of D'Amour and Smith (5) by the subcutaneous and the intravenous routes. It is apparent from Table 1 that deuteriomorphine is less potent than the parent compound in all categories tested. This is not due to slower absorption of the N—CD_3 compound since it is also less potent than the N—CH_3 compound when administered by the intracerebral and intravenous routes. In addition, passage through the organism does not seem to be slowed, since the onset of action and maximal effect and duration of action of ED_{95} doses was the same for both compounds. Thus, two of the several actions of morphine in mice—death by central nervous system stimulation and analgesia as measured by prolongation of reaction time to a thermal stimulus —are similarly influenced by deuterium substitution in the N—CH_3 group. A change in the potency of sympathomimetic amines upon deuteration in the α-position has recently been reported by Belleau and Burba (6).

These workers, however, observed an intensification as well as prolongation of effect on the nictitating membrane. Since the morphine molecule has been changed only by alteration of the

N–CH_3 group and is in all other respects essentially unaltered, the pharmacological differences noted should be related to the characteristics of the N–CD_3 group. Since the unionized alkaloid base preferentially enters the cell, difference in basicity might explain the difference in potencies, but this consideration seems less likely on the basis of the in vivo data relative to the routes of administration and the duration of action as well as by the in vitro data relative to the energy of activation of N-demethylation.

The effect of deuteration on N-demethylation in vitro was tested by measurement of formaldehyde evolved from a fortified incubate of rat liver microsomes and morphine or deuteriomorphine (*7*). The reaction showed the characteristics of a zero-order reaction for at least 15 min. For routine assay of the enzyme, incubation periods of 15 min were chosen. Substitution of D for H in the N–CH_3 group resulted in (i) a slower rate of demethylation since the ratio of the velocity constants $k_H/k_D = 1.4$, (ii) a higher energy of activation by 5 kcal/mole for the deuterated compound, and (iii) a weaker binding of the drug to the N-demethylating enzyme as evidenced by the difference in the Michaelis constants ($K_m^D/K_m^H = 1.43$). The velocity constants are measured rates of reaction at given substrate concentrations. The Michaelis constants (K_m's) were determined by incubating varying concentrations (S in the equation below) of the substrates with constant amounts of the enzyme. The amount of formaldehyde evolved in 15 min (v) was determined and fitted into the equation

$$\frac{S}{v} = \frac{1}{V_m}S + \frac{K_m}{V_m}$$

where V_m stands for the maximum velocity. Since this is a regression equation of S/v on S, the constants were determined by statistical methods in order to eliminate any bias that may be involved in drawing the curve.

The isotope effect of approximately 1.4 on both the Michaelis and velocity constants is considerably lower than 6.9, the maximum value of the deuterium isotope effect to be expected for the C–H bond (*8*). However, this ratio is observed only if the breaking of the C–H bond is the rate-limiting step. In N-demethylation of morphine, however, the simple oxidation of the C–H bond is apparently not the rate-limiting step.

Table 1. Comparison of the lethal and analgesic effects of morphine and deuteriomorphine in Swiss albino mice. Figures in parentheses are the 95-percent confidence limits. At dose levels near the 16, 50, and 84-percent response, 20 to 25 mice per dose level were used. At other dose levels, 10 to 15 mice per dose level were used.

Effect	Route	Dose (mg/kg)		$f_{P.R.}$*	P.R. of morphine to deuteriomorphine
		Morphine	Deuteriomorphine		
LD_{50}	Subcutaneous	256.0 (208–315)	400.0 (318–488)	1.32	1.56 (1.20–2.06)
LD_{50}	Intracerebral	6.9 (5.8–8.2)	11.4 (9.8–13.2)	1.26	1.65 (1.31–2.08)
ED_{50}	Subcutaneous	2.6 (2.2–3.0)	4.2 (3.5–5.2)	1.31	1.62 (1.25–2.15)
ED_{50}	Intravenous	1.1 (0.9–1.3)	3.3 (2.6–4.0)	1.30	3.00 (2.3 –4.9)

* P.R., potency ratio. For definition of $f_{P.R.}$, see (*11*). The value of P.R. must exceed the value of $f_{P.R.}$ for the two substances being compared to differ significantly in potency.

The ratio of the relative rates of demethylation in vitro is comparable to the ratios of the analgesic potencies and lethalities in vivo. These findings are consistent with but do not prove a relationship between N-demethylation and analgesic action. Beckett's theory is based on interrelated considerations of stereochemical configuration, physicochemical properties, and N-dealkylation of narcotic analgesics at the receptor sites (*1, 9*). The composite effects of these factors should be reflected in the magnitude of the Michaelis constant. Since deuteriomorphine is a stronger base than morphine, at the intracellular *p*H more of it will exist in the ionized form which is believed to be involved in binding to the receptors. Furthermore, the larger van der Waals forces associated with deuteriomorphine by virtue of the larger mass of its methyl group would lead one to expect a greater affinity of the enzyme for this drug than for morphine. The finding that the K_m^D is actually larger than the K_m^H implies a greater affinity of the enzyme for the more potent of the two homologous compounds. Therefore, the difference in potencies between morphine and deuteriomorphine could as easily be due to differences in affinities for the receptors as to differences in rates of demethylation.

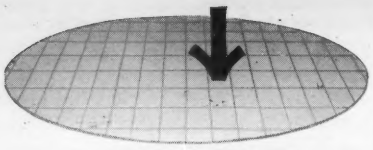
Other data relative to the rates of N-demethylation and the K_m of the N-demethylating enzymes with respect to other narcotic analgesics will be presented in a detailed publication (*10*).

C. Elison, H. Rapoport, R. Laursen, H. W. Elliott
Department of Pharmacology and Experimental Therapeutics, University of California Medical Center, San Francisco, and
Department of Chemistry, University of California, Berkeley

References and Notes

1. A. H. Beckett, A. F. Casey, N. J. Harper, *J. Pharm. and Pharmacol.* **8**, 874 (1956).
2. J. Axelrod, *Science* **124**, 263 (1956).
3. S. C. Mueller and G. A. Miller, *J. Biol. Chem.* **202**, 579 (1953).
4. This base strengthening effect of deuterium is similar to what we have found for codeine-N-CD_3, $pK_a = 8.19$ (26 percent stronger than codeine, $pK_a = 8.06$) and 2-phenylethylamine-1-d_2, $pK_a = 9.18$ (20 percent stronger than 2-phenylethylamine, $pK_a = 9.08$). A similar effect was noted by Halevi *et al.* [E. A. Halevi and M. Nussim, *Bull. Research Council Israel*, **6A**, 167 (1957)], who reported that benzylamine-α-d_2 was 13 percent more basic than benzylamine.
5. R. E. D'Amour and D. L. Smith, *J. Pharmacol. Exptl. Therap.* **72**, 74 (1941).
6. B. Belleau and J. Burba, *Science* **133**, 102 (1961).
7. J. Axelrod, *J. Pharmacol. Exptl. Therap.* **117**, 322 (1956); A. E. Takemori and G. J. Mannering, *ibid.* **123**, 171 (1958).
8. K. B. Wiberg, *Chem. Revs.* **55**, 713 (1955).
9. A. H. Beckett, *J. Pharm. and Pharmacol.* **6**, 986 (1954); A. H. Beckett and A. F. Casey, *ibid.* **8**, 848 (1956); A. H. Beckett, A. F. Casey, N. J. Harper, P. M. Phillips, *ibid.* **8**, 860 (1956).
10. This investigation was supported in part by research grant B-570 from the National Institutes of Health.
11. J. T. Litchfield and F. Wilcoxon, *J. Pharmacol. Exptl. Therap.* **96**, 99 (1949).

12 May 1961



Speaking of

Millipore®

Filters

STUDIES ON BACTERIAL PYROGENICITY II—A BACTERIOLOGICAL TEST FOR PYROGENS IN PARENTERAL SOLUTIONS

Basis and procedure for culture method with membrane filters to test freshly prepared parenterals for pyrogenic capacity is presented. Under conditions described, solutions which yielded counts less than 10,000 per L. were found nonpyrogenic by rabbit test. Laboratory and field trials indicate that MF bacteriological assay for purpose described is as specific and sensitive as rabbit assay.

Marcus, S., et. al., 1960, J. AM. PHARM. ASSOC., 49:9, p. 616-619, Sept.

. . . . . .

Millipore® filters are available in eleven pore-size grades from 5 μ down to 10 mμ. They retain on their surfaces *all* particles larger than rated pore size.
When writing for technical information please state your fields of interest.

Millipore® FILTER CORPORATION
Dept. S, Bedford, Massachusetts

GERM PLASM RESOURCES

AAAS Symposium Volume No. 66

Edited by Ralph E. Hodgson

394 pages, 59 illustrations
Index, Cloth, April 1961.

PRICE: $9.75. For AAAS members, Only $8.50, prepaid.

Origin of Germ Plasm—4 chapters

Need For and Utilization of Additional Sources of Germ Plasm —5 chapters

Developmental Programs in Crops and Livestock —5 chapters

New Approaches in the Use of Plant and Animal Germ Plasm —6 chapters

Perpetuation and Protection of Breeding Stocks —5 chapters

Order today from

American Association for the Advancement of Science

1515 Massachusetts Avenue, NW
Washington 5, D.C.

New Products

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Neither Science *nor the writer assumes responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to the manufacturer. Include the department number in your inquiry.*

Digital recording system for unattended data acquisition over long periods acquires synchronous data by a tape-stepping method. At a stepping speed of 30 steps per second, 38 hours of continuous recording are handled with one reel of tape. Data are recorded with track widths and spacings said to be compatible with most standard computers or data transcribing systems. Tape widths of ½, ¾, or 1 in. are available. (Minneapolis-Honeywell Regulator Co., Dept. Sci367, 10721 Hanna St., Beltsville, Md.)

Preset timer is designed for use with any transistorized scaler. Two time bases, interchangeable by insertion of plug-in cards, are provided: a 10-kcy/sec crystal-controlled oscillator and a 60-cy/sec line. A five-digit neon readout expresses elapsed time in tenths of a second for the 60-cy/sec base and in one-hundred-thousandths of a minute for the 10-kcy/sec base. Digits may be preset in any decade, one decade at a time. A printout feature is optionally available. (Eldorado Electronics, Dept. Sci366, 2821 10 St., Berkeley 10, Calif.)

Sweep generator has a center frequency range of 5 to 1200 Mcy/sec and a sweep width also 5 to 1200 Mcy/sec. The generator uses a voltage-tuned magnetron operating from 2400 to 3600 Mcy/sec and a fixed-frequency cavity oscillator at 2400 Mcy/sec. Their outputs are mixed, and the difference signal is the generator output. The two fundamentals and other high-frequency components are removed by a low-pass filter. An automatic gain control circuit continuously samples the swept output to assure uniform signal level. Flatness is said to be within ±2 db over a 100 Mcy/sec width and within ±0.75 db over-all. Output is greater than 0.25 volt (r.m.s.). (Telonic Industries Inc., Dept. Sci379, Beech Grove, Ind.)

Variable phase standard generates two signals of equal amplitude differing in phase by any angle from 0 to 360 deg as determined by front-panel controls. The reference signal has a fixed amplitude of 50 volts (r.m.s). The vector output, which may be displaced in phase, has a maximum amplitude of 50 volts (r.m.s.) and may be attenuated in steps of 50 mv. A front-panel selector switch permits operation of any of three frequencies within the range 150 to 3000 cy/sec. Each frequency can be varied over a ±5-percent range. Angular accuracy is said to be ±0.05 deg at any angle, and resolution is said to be 1 min. The instrument is self-contained, requiring no external equipment for operation or calibration. (Gertsch Products, Inc., Dept. Sci380, 3211 S. La Cienega Blvd., Los Angeles 16, Calif.)

Pump is designed to produce uniform flow over the range 30 to 500 ml/min. It is continuously adjustable over the entire range. Flow does not depart from average setting by more than 0.3 ml. The apparatus pumps against a back pressure of 300 mm-Hg. Flow rate is said to vary less than 2 percent with a pressure change from zero to 180 mm-Hg. A variable-speed drive unit, separately housed, may be distant from the pump. Hold-up volume of the pump is less than 40 ml. (Sage Instruments Inc., Dept. Sci383, 9 Bank St., White Plains, N.Y.)

Reference voltage source simulates the d-c electrical output of transducers with a setting accuracy said to be ±0.05 percent. The device consists of a potentiometer of infinite resolution and a bridge network supplied with 115 volt, 60 or 400 cy/sec current and Zener reference. Scale of the instrument, 12 ft long, can be graduated in several ranges in terms of the cardinal points of the instruments to be calibrated, or it can be graduated in a single range with up to 1000 scale divisions. The device is designed to test indicating instruments in the millivolt or microvolt range. (Howell Instruments, Inc., Dept Sci381, 3479 W. Vickery Blvd., Fort Worth 7, Tex.)

Null voltmeter has 13 zero-centered ranges from 1 mv to 1000 v end scale. Input impedance is 10 megohms in the most sensitive range and 200 megohms on the 300-MV and higher ranges. Accuracy is said to be within ±2 percent of end scale. The instrument provides an output proportional to meter deflection and can be used as a stable d-c amplifier. (Hewlett Packard Co., Dept. Sci371, 1501 Page Mill Rd., Palo Alto, Calif.)

JOSHUA STERN
National Bureau of Standards, Washington, D.C.

The University of Miami Press presents . . .

THE BIOLOGY OF AND OF SOME OTHER COELENTERATES: 1961 HYDRA

Edited by: Howard M. Lenhoff and W. Farnsworth Loomis

October 1961

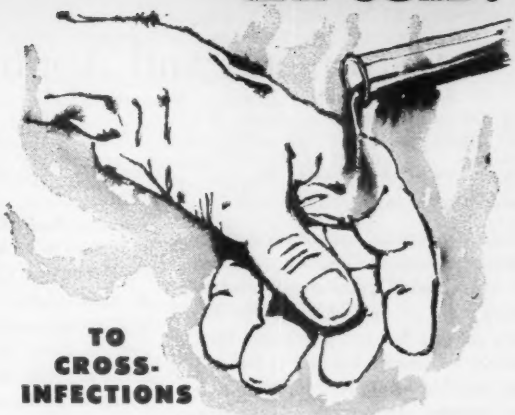
468 pp. 188 figures 37 tables cloth $4.50

During the past decade, there has been an increasing use of hydra as a laboratory animal; this trend is marked by the publication of THE BIOLOGY OF HYDRA: 1961. The volume is a record of an interdisciplinary symposium on the "Physiology and Ultrastructure of Hydra and of Some Other Coelenterates," held March 29-31, 1961 in Miami, Florida and in which twenty-five North American investigators representing many different fields of biology report on their current research. The following subjects are discussed: fine structure of hydra cells, intercellular attachments, mesoglea, and nematocysts; development, chemistry, pharmacology, and function of nematocysts; feeding reflex; nutrition; symbiosis; tissue culture; calcification; developmental patterns in colonial hydroids; sexual differentiation; aging of mortal and immortal coelenterate types; regeneration; and budding.

This volume should prove valuable to those seeking new material for their researches, and for the teacher using hydra as a classroom prototype.

THE UNIVERSITY OF MIAMI PRESS
CORAL GABLES 46, FLORIDA

EXPOSED!



TO CROSS-INFECTIONS

HANDS — most active in distribution of INFECTION! For the management and handling of specimen containers requiring a label, use a "no-lick" TIME Tape or TIME Specimen Collection Label for service, a new advancement specified in the "Guide to Laboratory Safety".*

Every dressing, every collection of specimen, blood, sputum, etc. requires hand service. Eliminate contact by using the satin finish, vinyl coated TIME Tape or Label.

A qualified consultant will teach you the effective TIME procedure. It is your first step to a safer laboratory. Write today to Dept. RH.

* *In April 1960 issue of Lab World.*

PROFESSIONAL TAPE CO., INC.
360-A BURLINGTON AVE. • RIVERSIDE, ILL.
Hickory 7-7800

MARK YOUR NUCLEAR CALENDAR

ATOM FAIR-'61

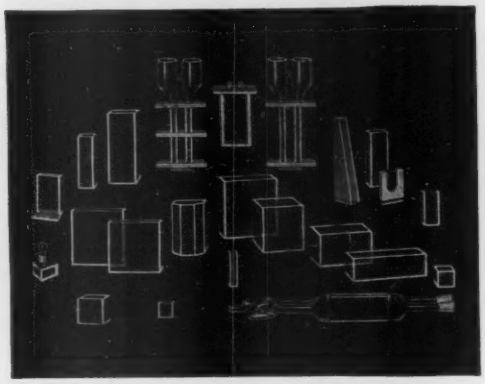
NOVEMBER 6-9
CONRAD HILTON HOTEL
CHICAGO, ILL.

In conjunction with annual meetings of
AMERICAN NUCLEAR SOCIETY
ATOMIC INDUSTRIAL FORUM

FOR COMPLIMENTARY EXHIBIT PASSES WRITE TODAY TO:

ATOMFAIR
850 THIRD AVENUE
NEW YORK 22

GLASS ABSORPTION CELLS made by KLETT



SCIENTIFIC APPARATUS
Klett-Summerson Photoelectric Colorimeters—Colorimeters — Nephelometers — Fluorimeters—Bio-Colorimeters — Comparators — Glass Standards—Klett Reagents.

Klett Manufacturing Co.
179 East 87 Street, New York, New York

Instruments and Applications

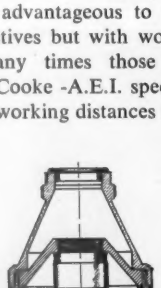
Phase contrast examination of tissue cultures in test tubes

Adequate optical examination of the living cell sheet while in the test tube (in which tissue cultures for routine virology are often and most conveniently grown) has not previously been possible — chiefly because it has not been possible to apply the phase contrast method. However, this is now feasible with the McCarthy Phase Apparatus, supplied as an accessory with the Cooke M15 microscopes, designed to give a phase contrast image (up to 150X-200X) of tissue cultures in a round 6″ x ⅝″ (150mm x 16mm) test tube.

In the McCarthy system provision is made for correction of astigmatism caused by the test tube and a special condenser system, compensated for the tube's cylinder effect, projects the substage phase annulus in the plane of the object.

High power microscope objectives with long working distances

Under unusual observation conditions and for some work involving the techniques of micro-manipulation, it would be advantageous to use "high dry" objectives but with working distances many times those normally obtained. Cooke -A.E.I. special objectives with working distances more than



15 times conventional values are sometimes used. Drawing shows the general construction, involving a mirror system which projects object image to a conventional microscope objective mounted behind. Working distance of both 20X and 40X objectives is 12.8mm, as contrasted with the normal working distance of approximately 0.71mm.

Numerical apertures are slightly reduced (to N.A. 0.57 in the case of a 40X achromat) and there is some loss of light inherent in the design. Excellent image quality is achieved, however, if cover glasses are close to the 0.18mm thickness for which the system is adjusted. Because of the mirror system, the objectives cannot be used on metallurgical specimens.

Biologists Polarizing Microscope

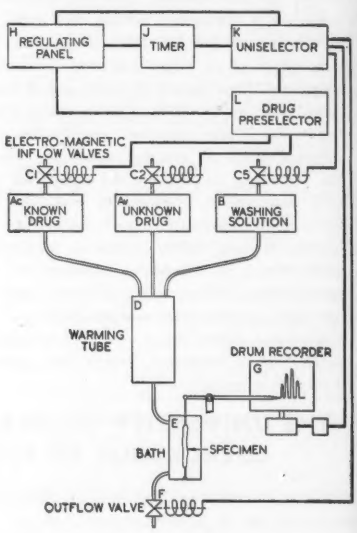
Many biological objects such as nerve, muscle, many plant fibres, etc., are moderately or even strongly birefringent. These objects can be studied with an ordinary polarizing microscope. Some specimens, however, particularly dividing cells, show only very weak bi-refringence. In order to study these specialized equipment is necessary. Very perfect extinction must be obtained and a special elliptic compensator employed.

In the Cooke Biologists Polarizing microscope a special $\lambda/20$ mica plate compensator is built into the substage, capable of rotation by an extended arm against an arc graduated from 0–120°, with a vernier reading in tenths of a degree. Special high-extinction polars are fitted to the microscope stand. With this equipment it is possible to measure with reasonable accuracy retardations down to $\lambda/1500$ (3.3A°) and to detect them down to $\lambda/3000$ (1.7A°). The mica plate compensator can be swung out of the optical train, allowing r al examination and measuremen chniques when these are desired.

Automated quantitative measurement of drug activity

In such applications as testing of anti-spasmodic drugs, histamine assays, potentiation and antagonist experiments, etc., the speed, accuracy and convenience of set-up and measurement procedures can be improved by use of the Casella Automatic Biological Assay Apparatus.

The apparatus controls the flow of drug and washing solutions into and out of the isolated organ bath, using electro-magnetic valves which compress rubber tubing.



The drug and washing solutions are contained in reservoirs Av, Ac and B respectively. When one of the air-inlets is opened by its valve C, the solution flows via the warming tube D into the jacketed isolated organ bath E — which is emptied by another electro-magnetic valve F. The contractions of the specimen are traced on the drum of a standard type of variable speed recorder G.

The cycle has been divided into several stages. The time required for each of these operations is independently variable over a very wide range. This is done by adjusting those controls on panel H which regulate the intervals between the pulses sent out by timer J to the uniselector switching device K. The order in which the drugs are added is decided by the position in which plugs are placed in the preselector L.

Biological • Metallurgical • Polarizing – **MICROSCOPES** – Student • Routine • Research • Special Research

COOKE, TROUGHTON & SIMMS, INCORPORATED
91 WAITE STREET, MALDEN 48, MASSACHUSETTS
IN CANADA: DON MILLS, ONTARIO

Metallographs • Dilatometers • Thermobalances • Particle Counting and Sizing Equipment

Meetings

Forthcoming Events

November

1. Rheumatic Fever, symp., New Haven, Conn. (E. A. Sillman, Connecticut Heart Assoc., 65 Wethersfield Ave., Hartford 14)

1–3. Alkaline Pulping, 15th conf., Houston, Tex. (Technical Assoc. of the Pulp and Paper Industry, 360 Lexington Ave., New York 17)

1–3. Experimental Mechanics, 1st intern. congr., New York, N.Y. (Soc. for Experimental Stress Analysis, P.O. Box 168, Central Sq. Station, Cambridge 39, Mass.)

1–3. High Magnetic Fields, intern. conf., Cambridge, Mass. (H. H. Kolm, Lincoln Laboratory, Massachusetts Inst. of Technology, Lexington 73)

1–3. Transplantation, CIBA Foundation symp. (by invitation), London, England. (CIBA Foundation, 41 Portland Pl., London, W.1)

1–4. American Soc. of Tropical Medicine and Hygiene, Washington, D.C. (R. B. Hill, 3575 St. Gaudens Rd., Miami 33, Fla.)

1–4. Society of Economic Geologists, Cincinnati, Ohio. (E. N. Cameron, Science Hall, Univ. of Wisconsin, Madison 8)

2–3. Cancer Chemotherapy, clinical symp., Washington, D.C. (T. P. Waalkes, Chemotherapy Natl. Service Center, NIH, Bethesda 14, Md.)

2–4. American Soc. for Cell Biology, 1st, Chicago, Ill. (H. Swift, Dept. of Zoology, Univ. of Chicago, Chicago 37)

2–4. Geochemical Soc., Cincinnati, Ohio. (F. R. Boyd, Jr., Geophysical Laboratory, 2801 Upton St., NW, Washington 8)

2–4. Geological Soc. of America, Cincinnati, Ohio. (F. Betz, Jr., GSA, 419 W. 117 St., New York 27)

2–4. Inter-Society Cytology Council, annual, Memphis, Tenn. (P. A. Younge, 1101 Beacon St., Brookline 46, Mass.)

2–4. National Assoc. of Geology Teachers, Cincinnati, Ohio. (D. J. Gare, Principia College, Elsah, Ill.)

2–4. Paleontological Soc., Cincinnati, Ohio. (H. B. Whittington, MCZ, Harvard Univ., Cambridge 38, Mass.)

2–4. Society for Industrial and Applied Mathematics, Washington, D.C. (Chairman, Program Committee, SIAM, P.O. Box 7541, Philadelphia 1, Pa.)

2–5. Mathematical Models in the Social and Behavioral Sciences, conf., Cambria, Calif. (F. Massarik or P. Ratoosh, Mathematical Models Conf., Graduate School of Business Administration, Univ. of California, Los Angeles 24)

3–4. Central Soc. for Clinical Research, Chicago Ill. (J. F. Hammarsten, Veterans Administration Hospital, 921 N.E. 13 St., Oklahoma City 4, Okla.)

4. Society for the Scientific Study of Sex, New York, N.Y. (H. G. Beigel, 138 E. 94 St., New York 28)

5–8. American Speech and Hearing Assoc., Chicago, Ill. (K. O. Johnson, 1001 Connecticut Ave., NW, Washington 6)

5–9. Society of Exploration Geophysicists, 31st annual intern., Denver, Colo. (C. C. Campbell, Box 1536, Tulsa 1, Okla.)

5–11. Stomatology of Peru, intern. congr., Lima, Peru. (A. Rojas, Avenue Pershing 155, San Isidro, Lima)

5–15. Japanese Chemical Engineers Soc., 25th anniversary congr., Tokyo and Kyoto, Japan. (Kagaku-Kogaku Kyokai, Shunichi Uchida, 609 Kojunsha Bldg. No. 4, 6-Chome, Ginza, Chou-Ku, Tokyo)

5–18. Latin American Phytotechnical Meeting, 5th, Buenos Aires, Argentina. (U. C. Garcia, Rivadavia 1439, Buenos Aires)

6–8. Association of Military Surgeons of the U.S., 68th annual, Washington, D.C. (R. E. Bitner, AMSUS, 1726 Eye St., NW, Washington 6)

6–8. Cell in Mitosis, 1st annual symp., Detroit, Mich. (L. Levine, Dept. of Biology, Life Sciences Research Center, Wayne State Univ., Detroit 2)

6–8. Chemical Engineering Div., Chemcal Inst. of Canada, Toronto, Ont. (CIC, 48 Rideau St., Ottawa 2, Ont.)

6–9. Atomic Industrial Forum–9th Hot Laboratories and Equipment Conf., Chicago, Ill. (O. J. Du Temple, American Nuclear Soc., 86 E. Randolph St., Chicago)

6–9. Southern Medical Assoc., Dallas, Tex. (R. F. Butts, 2601 Highland Ave., Birmingham 5, Ala.)

8. American Acad. of Arts and Sciences, Brookline, Mass. (J. L. Oncley, 280 Newton St., Brookline 46)

Announcing

International Edition

ANGEWANDTE CHEMIE

– in English –

Volume 1, Number 1, January 1962

The *international edition* of ANGEWANDTE CHEMIE is under the editorial supervision of Dr. W. Foerst who is also chief editor of the German-language ANGEWANDTE CHEMIE, founded in 1888. This journal has achieved great distinction in chemical literature and has often been chosen as the medium of publication by many distinguished scientists, including many Nobel Laureates.

Each number of ANGEWANDTE CHEMIE/*international edition* contains

- review articles
  from all fields of chemistry written by authorities—concise, easy to read, well documented
- selected papers
  from the affiliated journal "Chemie-Ingenieur-Technik"
- communications
  from all fields of chemical research, carefully selected to assure highest standards
- conference reports
  abstracts of lectures given at the most important European chemical meetings, covering unpublished results
- selected abstracts
  reporting the highlights from international chemical literature—fast, reliable
- book reviews

chosen from the semimonthly issues of the German edition.

Volume 1, about 600 pages (¾ of the German edition), will consist of 12 issues, to be released monthly.

Subscription price: $15.00 (plus postage)

Please place your order with your subscription agent or with one of the publishers.

A limited supply of sample issues, representing a complete translation of Volume 72, No. 22, November 21, 1960, has been prepared. A detailed brochure is available from one of the publishers:

ACADEMIC PRESS
111 Fifth Avenue
New York 3, New York
U. S. A.

17 Old Queen Street
London, S.W. 1
England

VERLAG CHEMIE, G.m.b.H.
Pappelallee 3
Weinheim/Bergstr.
Germany

8–10. Nondestructive Testing in Electrical Engineering, conf., London, England. (Secretary, Institution of Electrical Engineers, London W.C.2)

8–11. Acoustical Soc. of America, Cincinnati, Ohio. (W. Waterfall, American Inst. of Physics, 335 E. 45 St., New York 17)

8–11. Institute of Management Sciences, San Francisco, Calif. (W. Smith, Inst. of Science & Technology, Univ. of Michigan, Ann Arbor)

8–11. Plasma Physics, American Physical Soc., 3rd annual, Colorado Springs, Colo. (F. Ribe, Los Alamos Scientific Laboratory, P.O. Box 1663, Los Alamos, N.M.)

9–10. Operations Research Soc. of America, 20th, San Francisco, Calif. (P. Stillson, 115 Grove Lane, Walnut Creek, Calif.)

9–11. Gerontological Soc., Pittsburgh, Pa. (R. W. Kleemeier, Washington Univ., Skinker and Lindell, St. Louis 30, Mo.)

9–12. Pacific Coast Fertility Soc., Palm Springs, Calif. (G. Smith, 909 Hyde St., San Francisco 9, Calif.)

9–20. Photography, Cinematography, and Optics, 3rd intern. biennial, Paris, France. (Comité Francais des Expositions, 15 rue de Bellechasse, Paris 7)

12–17. Bahamas Conf. on Medical and Biological Problems in Space Flight, Nassau, Bahamas. (I. M. Wechsler, P.O. Box 1454, Nassau)

13–14. Exploding Wire Phenomenon, 2nd intern. conf., Boston, Mass. (W. G. Chace, Thermal Radiation Laboratory, CRZCM, Geophysics Research Directorate, Air Force Cambridge Research Laboratories, Bedford, Mass.)

13–16. Magnetism and Magnetic Materials, 7th annual intern. conf., Phoenix, Ariz. (P. B. Myers, Motorola, Inc., 5005 E. McDowell Rd., Phoenix 10)

13–17. American Public Health Assoc., 89th annual, New York, N.Y. (APHA, 1790 Broadway, New York)

13–17. Gulf and Caribbean Fisheries Inst., 14th annual, Miami Beach, Fla. (J. B. Higman, Marine Laboratory, Univ. of Miami, 1 Rickenbacker Causeway, Virginia Key, Miami 49)

13–18. European Conf. on the Control of Communicable Eye Diseases, Istanbul, Turkey. (World Health Organization, Palais des Nations, Geneva, Switzerland)

14–16. American Meteorological Soc., Tallahassee, Fla. (Executive Secretary, AMS, 45 Beacon St., Boston 8, Mass.)

14–17. Corrosion in Nuclear Technology, symp., Paris, France. (European Federation of Corrosion, Société de Chimie Industrielle, 28 rue St. Dominique, Paris 7°)

14–18. Puerto Rico Medical Assoc., Santurce. (J. A. Sanchez, P.O. Box 9111, Santurce)

15–17. Eastern Analytical Symp., New York, N.Y. (A. Rekus, EAS, Research Dept., Baltimore Gas & Electric Co., Pratt St., Baltimore, Md.)

15–18. Society of Naval Architects and Marine Engineers, annual, New York, N.Y. (W. N. Landers, SNAME, 74 Trinity Pl., New York 6)

16–18. American Psychiatric Assoc., Milwaukee, Wis. (J. D. McGucken, 756 N. Milwaukee St., Milwaukee 2)

16–18. Etiology of Myocardial Infarction, intern. symp. (by invitation), Detroit, Mich. (T. N. James, Section on Cardiovascular Research, Henry Ford Hospital, Detroit)

16–18. Southern Thoracic Surgical Assoc., Memphis, Tenn. (H. H. Seiler, 517 Bayshore, Blvd., Tampa 6, Fla.)

16–19. American Anthropological Assoc., Philadelphia, Pa. (S. T. Boggs, 1530 P St., NW, Washington, D.C.)

17–18. Southern Soc. for Pediatric Research, Atlanta, Ga. (W. G. Thurman, Dept. of Pediatrics, Emory Univ. School of Medicine, Atlanta)

17–31. National Soc. for Crippled Children and Adults, annual conv., Denver, Colo. (NSCCA, 2023 W. Ogden Ave., Chicago 12, Ill.)

19–22. International College of Surgeons, Western regional, San Francisco, Calif. (W. F. James, 1516 Lake Shore Drive, Chicago 10, Ill.)

22–27. Automation and Instrumentation, 5th conf., Milan, Italy. (Federezione delle Societa Scientifiche e Techniche di Milano, via S. Tomaso 3, Milan)

22–1. Radioisotopes in Animal Biology and the Medical Sciences, conf., Mexico City, D.F. (International Atomic Energy Agency, 11 Kärntner Ring, Vienna 1, Austria)

23–25. Central Assoc. of Science and Mathematics Teachers, Chicago, Ill. (J. Kennedy, Indiana State Teachers College, Terre Haute)

(See issue of 15 September for comprehensive list)

CONTROLS and RECORDS pH AUTOMATICALLY

The New Brunswick Automatic pH Controller provides *continuous* regulation, monitoring and recording of pH in any active fermentation or chemical process at laboratory, pilot plant or production levels.

This compact unit controls pH at any pre-selected level throughout the entire acid-base range with an accuracy of ± 0.1 pH. Specially constructed electrodes with insulated wire leads withstand *repeated* steam sterilization at temperatures up to 250°F and pressures to 100 psi.

The mobile apparatus, with electrodes, is readily integrated in New Brunswick Fermentors as well as most other fermentation vessels. Find out how this apparatus can solve your individual pH control problems. Unconditional One Year Warranty.

Write for Catalog PHS/10131

NBS **New Brunswick Scientific Co., Inc.**
1130 Somerset Street, New Brunswick, New Jersey

Manufacturers and Distributors of Precision Laboratory Apparatus

NO lost experiments with

MICROSCOPIC SLIDE LABELING

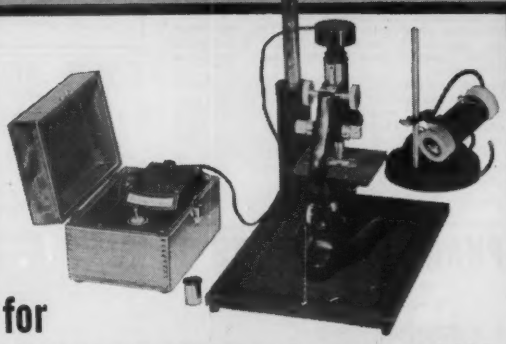
Eliminate guesswork . . . greasemark mistakes. Get positive identification. Simply pull tab and a fresh, clean label "pops" out. Fast, self-sticking labels dispensed one at a time. Available in standard or "tissue-high" thickness. They accept pen, pencil, ball point pen or typewriter marking. 1000 labels per carton.

TIME SELF-STICKING LABELS VINYL COATED

Write for detailed information and the name of your nearest TIME distributor.

PROFESSIONAL TAPE CO., INC.
360 Burlington Ave. • Riverside, Ill.

PHOTOVOLT EXPOSURE PHOTOMETER Mod. 200-M



for

PHOTOMICROGRAPHY

Accurate determination of exposure time in black-and-white and color photomicrography

Write for Bulletin #810 to **Price $125.00**

PHOTOVOLT CORP.
1115 Broadway New York 10, N. Y.

PERSONNEL PLACEMENT

CLASSIFIED: Positions Wanted 25¢ per word, minimum charge $4. Use of Box Number counts as 10 additional words. Payment in advance is required.

COPY for ads must reach SCIENCE 2 weeks before date issue (Friday of every week).

DISPLAY: Positions Open. Rates listed below—no charge for Box Number. Rates net. No agency commission allowed for ads under 4 inches. No cash discount. Minimum ad: 1 inch. Ads over 1 inch will be billed to the nearest quarter inch. Frequency rate will apply to only repeat of same ad. No copy changes. Payment in advance is required except where satisfactory credit has been established.

Single insertion	$40.00 per inch
4 times in 1 year	38.00 per inch

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

Replies to blind ads should be addressed as follows:
Box (give number)
Science
1515 Massachusetts Ave., NW
Washington 5, D.C.

POSITIONS WANTED

Editor, formerly with Forest Service, seeks freelance assignments by mail. Wendell Smith, Rock Harbor, Orleans, Mass. 10/20

Microbial Geneticist, Ph.D. Phage transduction, transformation, animal viruses, tissue culture, molecular biology. Teaching and research. Box 201, SCIENCE. X

Parasitologist-Microbiologist; 7 years of college teaching. Research grants, Latin American and African experience. Desires position as professor or department head. Box 198, SCIENCE. X

POSITIONS WANTED

Electroencephalographer Neurologist M.D. certified; 20 years of clinical and experimental experience. Significant contributions. Will relocate for academic position. Box 202, SCIENCE. X

Zoologist-Embryologist. Principal interest—students. Extensive experience. Small school with high standards preferred. Box 199, SCIENCE. X

POSITIONS OPEN

BIOCHEMIST

Required by The West African Cocoa Research Institute at Tafo, Ghana, to conduct studies on cocoa fermentation as affecting flavour and quality. Appointment on contract for two tours of 15 to 18 months in the first instance.

Salary according to qualifications and experience in scale £1248 a year rising to £2820 a year. Gratuity at rate of £150 a year payable at end of a tour or on final completion of service. Free passages for officer and wife. Assistance towards children's passages or allowance up to £300 a year if educated in U.K. Liberal leave on full salary. Quarters available at moderate rental.

Candidates must possess a good honours degree in Chemistry or Biochemistry and have had not less than 2 years post-graduate training or approved research experience in Biochemistry. Women candidates must be single.

Apply to CROWN AGENTS, 4 Millbank, London, S.W.1., England, for application form and further particulars, stating age, name, brief details of qualifications and experience and quoting reference M3B/53566/SCN.

POSITIONS OPEN

PHARMACOLOGIST

Ph.D. with special training in neuropharmacology. Senior and responsible position. Administrative ability, for expanding research department of upstate New York pharmaceutical company.

Box 200, SCIENCE

VIROLOGISTS and BIOCHEMISTS

Ph.D., M.D. or D.V.M.

. . . with experience in virology, microbiology, or related biological subjects. Virus and immunology research with substantial tissue culture experience.

BIOCHEMIST

B.S. or M.S.

. . . with strong background in organic or biochemistry. Write stating qualifications and salary desired to

PERSONNEL DEPT.

WYETH

Box 8299 **Philadelphia 1, Pa.**

POSITIONS OPEN

FACULTY OF AGRICULTURE

The University of Alberta invites applications for a position in the department of animal science as assistant professor (poultry genetics) at a starting salary of $7400 with excellent prospects for advancement. Candidates must have a Ph.D. or equivalent in poultry genetics. The appointee will be expected to develop a research program in poultry genetics and to carry some teaching responsibilities.

Forward applications, accompanied by a recent photograph, curriculum vitae, transcript of academic record, and names and addresses of three references to the Head, Department of Animal Science, University of Alberta, Edmonton, Alberta. Closing date: **1 January 1962**; duties to commence as soon as possible thereafter but not later than 1 July 1962. 10/20

PHARMACOLOGISTS

Three Ph.D.'s required for group leader positions

1. **NEUROPHYSIOLOGY GROUP**
   Concerned with neuropharmacological & electro-physiological research & service functions.
2. **GENERAL NEUROPHARMACOLOGY GROUP**
   Supervise CNS drug screening and evaluative programs.
3. **AUTONOMIC PHARMACOLOGY GROUP**
   Research & drug evaluation primarily in areas of allergy & hypertension.

Send resume and Salary requirements To Personnel Department

SCHERING CORP.

60 Orange St. Bloomfield, N.J.

Senior Pharmacologist. Ph.D., 2 or 3 years of experience preferred, but not absolutely essential. Senior and responsible position in new laboratory facilities of established, progressive pharmaceutical firm. Involves direction, supervision and mechanism studies in pharmacological evaluations of new and novel organic compounds. Excellent opportunities for personal and professional advancement. All replies confidential. Send résumé to Director of Research, **Irwin, Neisler Research Laboratories**, 1800 E. Pershing Road, Decatur, Ill. X

SENSORY EVALUATION PANEL

A position is available for a person with at least a master's degree to organize and direct a "taste panel" to evaluate the effects of ionizing radiation on fresh fruits and vegetables. Write Dr. C. O. Hesse, Chairman, Department of Pomology, **University of California,** Davis, California.

VIROLOGISTS

with

Production Experience

We need an experienced man capable of supervising human biologicals production. Opening is at Terre Haute, Indiana.

Address resume, outlining experience, education, military status and salary requirements, to:

W. H. Harrington

Chas. Pfizer & Co., Inc.

235 East 42 Street

New York 17, N.Y.

Pfizer

POSITIONS OPEN

Effective 1 January 1962

The rates for advertising in the Positions Open section of **Science** will be increased to $50 per inch.

FELLOWSHIPS

Postdoctoral Fellowship in Biochemistry, involving blood proteins, available immediately. $6000 to begin, partially tax free, no tuition. For further information write to Assistant Director for Education, Office of Education,

The University of Texas
M.D. Anderson Hospital and Tumor Institute
Texas Medical Center, Houston 25

EDUCATION AND RESEARCH IN BIOMEDICAL ENGINEERING

An educational program designed to prepare life and physical scientists, doctors of medicine, and engineers for research in life systems through the current period of transition of biological sciences from the natural history stage of inquiry by inductive empiricism to that of inquiry by deductively formulated theory. An intensive four-term (12-month) preparation in methods of logical thought, mathematics, physics, and electrical theory for doctors of medicine and biologists, and a one-term (3-month) preparation in life sciences for engineers, makes possible joint course work in the final three terms (nine months). Thesis research on biological systems is conducted at the Presbyterian Hospital by teams drawn from both disciplines. The program leads to a graduate degree at Drexel. Limited stipend and scholarship funds are available. Assistance with fellowship application to National Institutes of Health is offered. For information:

James W. Dow, M.D.
Department of Biomedical Engineering
DREXEL INSTITUTE OF TECHNOLOGY
15 North 32 Street
Philadelphia 4, Pennsylvania

The **Department of Pharmacology, University of Buffalo School of Medicine,** Buffalo 14, N.Y., offers a 4-year program of course work and research training leading to the Ph.D. degree. Research opportunities include the action of drugs on kidney, heart and circulation, autonomic ganglia and skeletal muscle, and connective tissue. Annual stipends of $1800 to $2200 plus full tuition, plus $500 for each dependent. Applications now being considered for entrance February or September 1962. Detailed information supplied on request.

NATIONAL RESEARCH COUNCIL OF CANADA POSTDOCTORATE FELLOWSHIPS 1962–63

Approximately 120 fellowships will be awarded for 1962–63 by the National Research Council. Of these, 40 will be tenable in National Research Council laboratories in Ottawa, Saskatoon, and Halifax; 15 in laboratories of the Department of Agriculture, located at various centers; 15 in laboratories of the Department of Mines and Technical Surveys in Ottawa and Victoria; 5 in the laboratories of the Department of National Health and Welfare in Ottawa; 8 in the laboratories of Atomic Energy of Canada Limited; and 40 in laboratories of Canadian universities.

Applicants should not be more than 35 years of age and should possess a Ph.D. degree from a recognized university, or expect to obtain such a degree before taking up an award. (Candidates having equivalent research experience may be considered.) There are no restrictions regarding nationality of applicants, but successful candidates must meet all Canadian immigration requirements.

The annual stipend, which is free of income tax, is $4000 for single fellows and $5000 for male fellows who are married. An allowance toward the cost of travel is also paid.

The fields in which fellowships are available in the laboratories of the National Research Council, the Department of Agriculture, and the Department of Mines and Technical Surveys are described in greater detail in booklets that may be obtained on request, together with application forms. Applicants who are interested in fellowships in the universities may write directly to these institutions, or to the National Research Council for information. The fields of interest should be stated in the initial inquiry in order that appropriate information may be supplied. The closing date of the competition is **15 January 1962.**

Inquiries should be addressed to:

Awards Officer
NATIONAL RESEARCH COUNCIL
Ottawa 2, Canada

The Market Place

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

DISPLAY: Insertions must be at least 1 inch in depth. Weekly invoices will be sent on a charge account basis—provided that satisfactory credit is established.

Single insertion	$48.00 per inch
4 times in 1 year	44.00 per inch
13 times in 1 year	42.00 per inch
26 times in 1 year	40.00 per inch

PROOFS: If copy is to be set, and proofs submitted for approval, complete copy and cuts must be received 4 weeks in advance of publication date (Friday of each week); complete plates no later than 3 weeks in advance of publication date.

BOOKS AND MAGAZINES

Your sets and files of scientific journals

are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dept. A3S, CANNER'S, Inc. Boston 20, Massachusetts

FOR UP-TO-DATE INFORMATION ON
GAS CHROMATOGRAPHY
READ AEROGRAPH RESEARCH NOTES
write for your free subscription
WILKENS INSTRUMENT & RESEARCH INC.
Box 313-A • Walnut Creek, Calif.

SUPPLIES AND EQUIPMENT

YOU NEED THIS **FREE** CATALOG FOR YOUR FILES

Serums, antiserums and bloods of all kinds for technicians and tissue culture laboratories. No salesman will call.

COLORADO SERUM CO.
4950 York St. • MAin 3-5373 • Denver 16, Colo.

• **HYPOPHYSECTOMIZED RATS**
Shipped to all points via Air Express
For further information write
HORMONE ASSAY LABORATORIES, Inc.
8169 South Spaulding Ave., Chicago 29, Ill.

1919 - 1961
LaMotte Chemical
Chestertown, Maryland, U.S.A.
Specialists in
Colorimetric Techniques
Reagents-Standards-Comparators
Send for Illustrated
Controls Handbook **Dept. H**

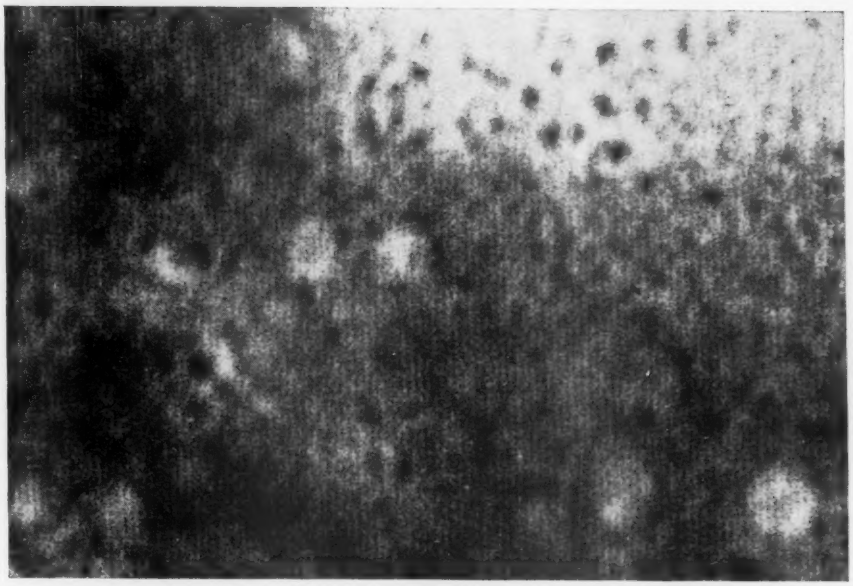
CHARLES RIVER *CD-1
(Caesarean-derived)

HIGH STRESS

ALBINO **Mice** SWISS ICR

Hypophysectomies available
*Trademark
THE CHARLES RIVER MOUSE FARMS
1018 Beacon St., Brookline 46, Mass., RE 4-2000

EXPLORING FUNDAMENTALS
. . . with the HITACHI HU-11



Shown is a microphotograph of Potassium Chloro Platinite, taken with an Hitachi HU-11 Electron Microscope, 1,750,000 photographic magnification, and with a resolution of 6.99 Angstrom Units!

Hitachi's guaranteed 8–10 Angstrom Unit resolution allows you to probe the very basic structure of matter—making full use of the HU-11's 250,000 direct magnification.

The basic Hitachi HU-11, without accessories, serves as a highly efficient electron diffraction apparatus for use with opaque or transparent specimens. With such accessories as a low temperature stage, a high temperature stage, a reflection microscopy attachment and a X-Ray shadow camera, the Hitachi HU-11 allows investigations into every field of research.

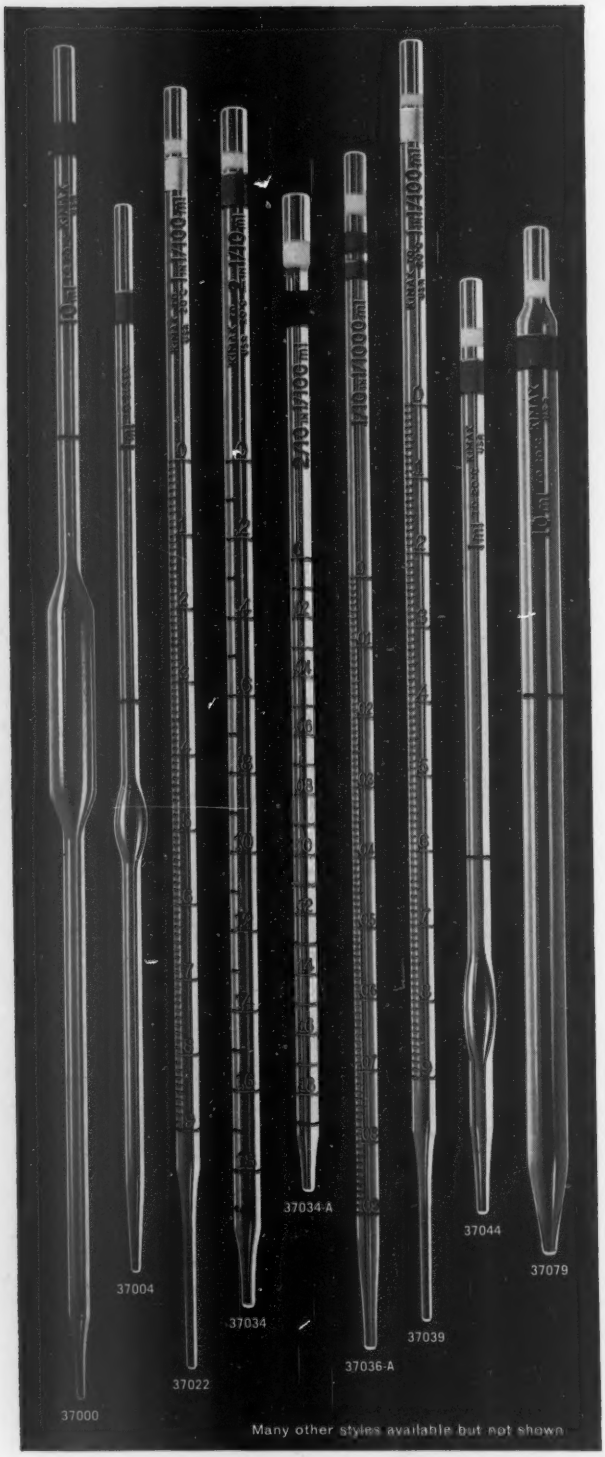
LEASE TERMS ARE NOW AVAILABLE

ERB & GRAY SCIENTIFIC, Inc.

Exclusive Hitachi distributors for the United States

5927 Riverdale Ave., New York 71, N.Y. • **1103 Westgate Ave., Oak Park, Illinois**

854 S. Figueroa St., Los Angeles 17, Calif.



Kimble offers—at no extra cost...

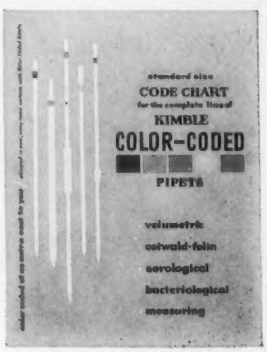
the world's most complete line of COLOR-CODED pipets.

Including Volumetric, Ostwald-Folin, Measuring, Serological and Bacteriological pipets.

Your laboratory dealer now has stocks of at least 20 varieties of Kimble pipets, color-coded to provide these advantages for your laboratory:

- ♦ INSTANT SIZE IDENTIFICATION
- ♦ REDUCED SORTING TIME
- ♦ LESS CHANCE OF ERROR
- ♦ SIMPLIFIED CODING SYSTEM
- ♦ LONG-LASTING COLOR BANDS
- ♦ CODED, EASY-OPEN CARTONS

There's no extra charge for color-coding. And, Kimble dealers* offer new discounts of 28% when your order for assorted Kimble ware totals 150 cases.
*In Fair Trade States.



Send for this handy Kimble color/size code chart. Drop a card to Kimble Glass Company, Dept. CC2, (SC-10) Toledo 1, Ohio.

KIMBLE LABORATORY GLASSWARE
AN (I) PRODUCT

OWENS-ILLINOIS
GENERAL OFFICES · TOLEDO 1, OHIO